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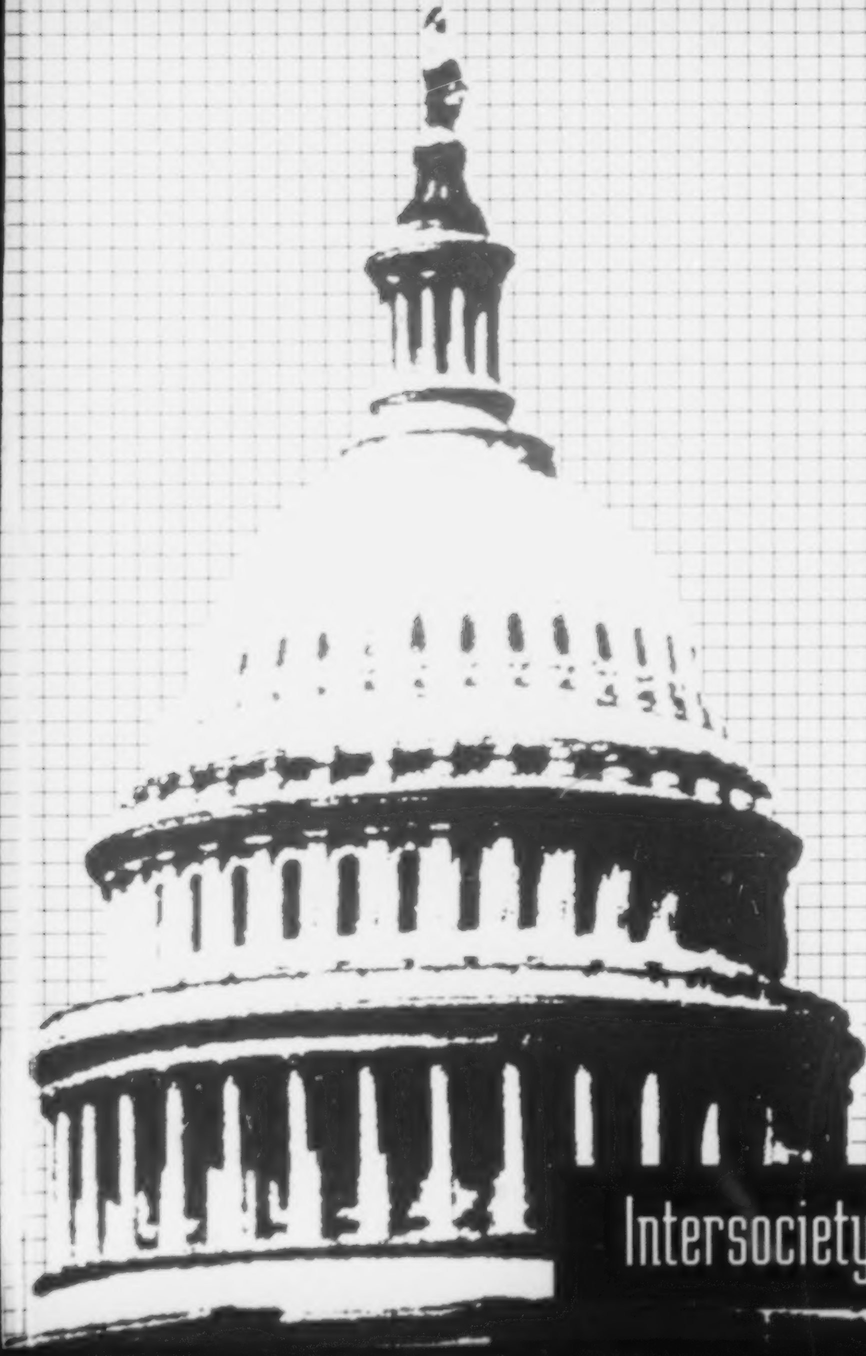
# AAAS REPORT XVIII

# RESEARCH AND DEVELOPMENT FY 1994



Intersociety Working Group

# AAAS REPORT
# XVIII

# RESEARCH AND DEVELOPMENT FY 1994

Intersociety
Working
Group

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Committee on Science, Engineering, and Public Policy
1333 H Street, NW, Washington, DC 20005

The AAAS Board of Directors, in accordance with Association policy, has approved publication of this report as a contribution to the understanding of an important process. The interpretations and conclusions are those of the authors and do not purport to represent the views of the Board or the Council of the Association.

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# Preface

The purpose of this annual series rests on a few straightforward observations. Scientific research and development (R&D) are of vital importance to the United States in the 1990s. The federal government supports nearly half of the nation's R&D, and its policies profoundly affect the institutions in which this work is carried out. The President's annual budget and the congressional debate that ensues are the mechanisms through which policies and priorities for R&D are set. Since 1976 the AAAS has published annually a report analyzing R&D in the proposed federal budget in order to make available to the scientific and engineering communities and to policymakers timely and objective information about the Administration's plans for the coming fiscal year.

This is the eighteenth in the series of AAAS R&D Reports. The effort was begun in-house at AAAS by Willis H. Shapley, under the auspices of the Committee on Science, Engineering and Public Policy. It is now a collaborative effort involving contributors from 22 scientific, engineering, higher education, and industrial associations known collectively as the Intersociety Working Group.

This report is based upon President's Clinton's proposed budget for FY 1994, which was officially released on April 8. This release was at least two months later than normal, largely because the outgoing Bush Administration did not prepare a FY 1994 budget, and the new Administration essentially had to start from scratch. Severe time pressures also precluded a thorough analysis of research and development as a separate topic within the budget document. Instead one finds a shorter description of several R&D budget highlights, as the Administration sees them, set in the context of the Administration's overall approach to R&D policy.

This volume is one of several publications and activities of the AAAS R&D Budget and Policy Program. In addition to functioning as a stand-alone document, the report (usually published in March) serves as background for the Annual AAAS Colloquium on Science and Technology Policy, held in Washington, DC in mid-April.

A new annual volume, the *AAAS Science and Technology Policy Yearbook*, has replaced the old Proceedings of the S&T Policy

Colloquium as the second publication in the R&D Program's annual series of three publications. This book contains most of the major Colloquium addresses, as well as both original and previously published articles by leading figures in science and technology policy. The third publication appears in the fall or winter, after Congress has completed its appropriations process. At that time AAAS, in collaboration with the Intersociety Working Group, will publish its annual review of the impact of congressional decisions on R&D, *Congressional Action on Research and Development in the FY 1994 Budget*. Registrants for the Colloquium will receive copies of all three of these publications.

The structure of this report parallels that of recent editions. Part I, the overview, includes discussions of the budgetary context of R&D and major funding trends, as well as analyses of funding for basic research and R&D in colleges and universities. Chapters on R&D in industry and funding for science, engineering and mathematics education are also included in Part I. Although neither of these is concerned strictly with R&D in the federal budget, each deals with closely related funding and policy matters that help define the context within which federal R&D is discussed and debated. A set of overview tables appears at the end of this section.

The chapters in Part II examine the proposed R&D budgets of major federal agencies and departments. Tables detailing those budgets and the budgets of several smaller agencies and departments not featured in the chapters are included at the end of Part II.

Finally, Part III consists of a set of cross-cutting analyses that look at the budget in terms of disciplines and areas of research.

Readers should be aware that the chapters in this report have been prepared largely independently of one another and under extremely tight deadline pressure. Although every effort has been made to avoid them, some overlap, errors, and inconsistencies among the chapters are, unfortunately, inevitable.

On behalf of the members of the Intersociety Working Group, we would like to express our appreciation to the officers, members, and staffs of the participating organizations for their support and assistance in preparing this report — particularly the secretaries who facilitated our efforts to put this unruly, multiple-authored volume into a common format and single typeface for the first time. Our thanks also to the AAAS Committee on Science, Engineering and Public Policy, which initiated the R&D Program and periodically reviews it and provides guidance to it. We are very grateful to the individuals in the Office of Management and Budget, in other federal agencies, on congressional staffs and elsewhere, who aided us in collecting the information and advised us on its interpretation. We also owe special thanks to several AAAS staff members for their dedication and heroic efforts in preparing this volume for publication: Shirley Young and Elizabeth Gehman of the Directorate for Science and Policy Programs; Beth Goodrich of the Directorate for Education and Human Resources; and the Production staff of the AAAS Publications Office.

Albert H. Teich
Stephen D. Nelson
Kathleen M. Gramp

*Washington, DC*
*May 1993*

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# General Notes

## BASIS OF BUDGET STATISTICS

Budget statistics are presented on three bases: (1) **budget authority**, corresponding to the funds appropriated each year; (2) **obligations**, indicating the amounts of contracts and grants entered into; and (3) **outlays**, representing the amounts actually expended. Because budget decisions in the Executive Branch and in Congress are almost always made in budget authority, this basis most accurately reflects current changes in budget policies. Outlay trends lag a year or more behind decisions in budget authority, and obligations estimates are often adjusted to meet fiscal or budget strategy demands. We have, therefore, selected budget authority as the most meaningful measure of budget decisions and trends and used it in nearly all cases throughout the report.

## BASIS RESEARCH, APPLIED RESEARCH, AND DEVELOPMENT

The allocation of agency budgets among basic research, applied research, and development is not an exact procedure; a certain arbitrariness is inevitably involved. The severe time pressures under which these figures are complied for OMB are also a problem. Nevertheless, there is presumably some consistency within each agency's estimates so that the trends are meaningful.

## ROUNDING NUMBERS

Due to rounding in the tables, the detail may not add to the totals, and the percentage changes may not correspond exactly to the difference shown.

# Part 1: Overview

# 1

# Overview and Policy Issues for FY 1994

*Kathleen M. Gramp, Albert H. Teich,*
*Stephen D. Nelson, AAAS*

## HIGHLIGHTS

President Bill Clinton's *Vision of Change For America* recommends some new directions for federal R&D. As outlined in the Administration's first budget blueprint, overall funding for R&D would remain level in inflation-adjusted terms, but the balance among programs would change. The $75.4 billion portfolio would be tilted in favor of nondefense R&D, which would receive nearly 44 percent of the FY 1994 total, compared to 42 percent in FY 1993. Funding for nondefense R&D would increase to $32.9 billion, growing at about the same pace proposed for other domestic programs. Defense R&D funding would remain at $42.5 billion, while other defense appropriations are slated to decline by nearly 4 percent.

Within nondefense R&D, the President would channel most of the new money to applied research and technology, especially in areas related to the economy, infrastructure, and the environment. An increasing share of defense R&D would promote linkages with the civilian economy, such as R&D on dual-use technologies at the Department of Defense (DOD) and Cooperative Research and Development Agreements (CRADAs) at the Department of Energy's (DOE's) labs. As part of this shift, the Administration expects to encourage more cooperative R&D with industry, but envisions little real growth in university-based research. Apart from the double-digit increase proposed for the National Science Foundation (NSF), funding for basic research would fall in constant dollar terms.

Faced with daunting projections of the deficit doubling in ten years, the Administration also proposed a series of measures to control outyear spending, including limits on the construction of certain large-scale, multi-year R&D projects. Pending approval of a new, less expensive design for the space station, the National Aeronautics and Space Administration (NASA) requested the amount previously projected for FY 1994, promising that any surplus funds would be spent on new technology development. The White House also suggested stretching out DOE's construction schedule for the superconducting super collider (SSC), but asked for higher funding for FY 1994 for current construction costs.

## POLITICAL AND ECONOMIC CONTEXT OF THE FY 1994 BUDGET

Four weeks after coming into office, the new Administration outlined an ambitious plan to change the course of government. The President called for a reversal of the fiscal policies of the previous twelve years, suggesting a new slate of priorities premised on three goals: reducing the deficit, stimulating the economy, and redirecting federal resources to investments that improve the nation's productivity.

The Clinton plan blended spending cuts with spending increases, and tax hikes with tax cuts. On the one hand, the President spelled out proposals which the Congressional Budget Office (CBO) estimated would save $652 billion over the next five years:[1] $337 billion from new revenue (taxes, fees, and improved compliance), $85 billion from reforms of mandatory programs, $159 billion from reductions in discretionary appropriations (virtually all of which would come from defense), and $71 billion corresponding to lower debt servicing costs.

At the same time, however, the Administration's plan would chip away at these savings by spending more for priority programs and tax breaks. As part of his strategy to jump-start the economy, the President proposed a $16.3 billion stimulus package for FY 1993, comprised of supplemental appropriations totalling $12 billion and expanded funding for unemployment compensation and other mandatory programs. As part of his effort to redirect future spending, the President sought "investments" in infrastructure, lifelong learning, health, and work incentives, beginning with additional appropriations of $18.5 billion in FY 1994, and $190 billion in the subsequent four years. The investment package also proposed a series of tax incentives, such as the R&D tax credit, and improved benefits under selected entitlements (*e.g.*, the earned income tax credit and food stamps).

---

[1] At the time this report went to press, CBO had not released its analysis of the President's detailed budget, which was submitted on April 8, 1993. Officials expect the results of that analysis to be consistent with the findings summarized here.

CBO estimated that these stimulus and investment proposals would offset $297 billion of the gross savings in the Clinton plan. The tax incentives would cost the Treasury an estimated $70 billion over the next five years. Outlays would increase by $54 billion from FY1994 through FY1998 because of proposed changes in entitlements, and by $151 billion because of higher discretionary spending. Thus, after adjusting for debt service expenses, CBO estimated that of the $362 billion net deficit reduction anticipated under the President's plan, three-quarters would be derived from increasing revenues and the balance from reducing spending.

The Democrat-controlled Congress initially responded favorably to the President's policy agenda, moving with record speed on a concurrent budget resolution for FY 1994. Eager to show their commitment to deficit reduction, lawmakers devised a resolution intended to save $452 billion over the next five years, $90 billion more than suggested by the President (both estimates are relative to the CBO baseline). The resolution passed both chambers nearly a week before the Office of Management and Budget (OMB) released its detailed budget for FY 1994 on April 8.

Under the congressional resolution, the burden of achieving most of the savings falls on the authorizing committees. Authorizing committees must enact "reconciliation" legislation that would raise revenues by $273 billion over the next five years (equivalent to an average increase of 4 percent), and trim mandatory spending by an average of 2 percent. The resolution assumes a continuation of the existing caps on discretionary appropriations through FY 1995, leaving spending for the next two years near the levels expected under current policies. In the subsequent three years, however, discretionary outlays are supposed to be cut by a total of $67 billion, which is equivalent to a 4 percent reduction over that period.

Appropriators are not off the hook, however. The amounts appropriated last year left no wiggle room under the outlay cap in the Budget Enforcement Act (BEA) for domestic discretionary programs in FY1993. (For details on how Congress shaped the FY1993 budget and its impact on R&D, see *Congressional Action on R&D in the FY 1993 Budget*, published by AAAS in January 1993.) Thus, the only way Congress could fund the President's proposed stimulus package was to designate the programs as "emergency" spending which would be exempt from the caps. While most Democrats were willing to exercise this option, Senate Republicans refused to go along, demanding that the supplemental appropriations be offset by cuts elsewhere. The Republicans succeeded in blocking the measure, underscoring the limited maneuverability under the BEA.

Appropriators' task will not be much easier for FY1994. While the "firewalls" that prohibited moving money among defense, domestic, and international programs are gone, the overall caps on discretionary spending continue to shrink. Budget authority for all three categories must be cut by about 4 percent from FY1993 to FY1994, and outlays by roughly 2 percent. CBO observed that these caps would allow nondefense programs to be continued at their real, inflation-adjusted FY 1993 level if defense outlays were cut about 5 percent, to about $276 billion.

President Clinton proposed defense outlays of only $278 billion in FY 1994, but the caps are too tight to accommodate the "investments" he wants to make in nondefense discretionary programs. This is not surprising, because the investment initiatives would yield a 6.9 percent increase for nondefense programs, which amounts to real growth of nearly 4 percent. Thus, while Clinton's plan complies with the BEA's $513 billion cap for budget authority, it exceeds the FY1994 outlay limit—and budget resolution target—by about $7 billion.

Whether and how lawmakers choose to finesse the caps will have important implications for President's $75.4 billion request for R&D in FY1994 (up 3.1 percent over FY1993, zero growth after adjusting for inflation). As shown in Tables I-1 and I-2, R&D accounts for about 13 percent of the government's discretionary spending. The ill-fated stimulus proposal would have added $0.5 billion for R&D this year, mostly for basic research at the National Science Foundation (NSF) and industry-related R&D at the National Institute of Standards and Technology (NIST). R&D also has a stake in the President's "investment" initiatives: about 70 percent of the new money proposed for R&D in FY1994 was in the separate "investment" package.

## R&D IN THE FY 1994 BUDGET

Viewed in aggregate terms, the 3.1 percent increase proposed by the President for R&D in FY1994 looks good when compared to loss of budget authority projected for all discretionary programs. R&D beat the average largely because the Administration proposed a slight increase in funding for defense R&D (up 0.5 percent to $42.5 billion) while sharply cutting other defense spending. Because of this favored treatment, R&D would receive a rising share of national defense outlays, representing 15.2 percent of the total under the Clinton budget compared to 12.8 percent in FY 1992. As a percent of the gross domestic product (GDP), the amount devoted to defense R&D would drop back to its FY 1980 share (see Table I-2).

In contrast, the $32.2 billion proposed for nondefense R&D provides a year-to-year gain of 6.6 percent, which closely tracks the 6.9 percent increase projected for other nondefense appropriations. With the exception of R&D at the Agency for International Development (AID), all of this money falls in the domestic discretionary category. R&D's share of domestic discretionary spending would remain near 13 percent, but its share of GDP would go up, because of the President's proposal to increase funding in real terms. On the other hand, the Administration has requested less money for R&D at AID, which would lower R&D's share of international discretionary spending.

## Functional Distribution of Funding

The functional profile of the President's R&D request illustrates some of the trade-offs made to balance the dual goals of deficit reduction and long-term investments. As shown in Table I-4, national defense remains the single largest focus of the federal R&D effort, receiving a shrinking but still sizable 56 percent of the total. DOD would spend $39.3 billion in FY 1994 (up 1.1 percent), devoting most of the new money to defense-wide initiatives (*e.g.*, dual-use technologies) and the services' tactical programs. The name and mission of the Strategic Defense Initiative Office would be changed, but its budget would remain near FY 1993 levels. Funding for DOE's Atomic Energy Defense Activities would fall 7.3 percent to $3.0 billion, with reductions cutting across most programs. Technology transfer at DOE's weapons labs is one of the few growth areas.

The Clinton plan would expand the government's support for nondefense R&D selectively. The $2.0 billion increase over FY 1993 would be distributed as follows:

- Industry-related R&D (commerce) would be the fastest growing area, up 35.5 percent (or $119 million) from FY 1993 levels. The Administration wants to expand cost-shared R&D on pre-competitive generic technologies under the Advanced Technology Program and double NIST's intramural R&D over the next four years.
- Funding for R&D related to transportation ranks second, with a proposed increase of 22.0 percent, up $328 mil-

lion. Three-quarters of the new money would be used to expand NASA's R&D on aeronautics (*e.g.*, supersonic and subsonic transport) and the National Aerospace Plane. The Department of Transportation (DOT) would boost R&D on aviation, high speed rail, magnetic levitation trains, and intelligent vehicles and highways.

- In dollar terms, the largest increase would go to general science (up $573 million, or 16.5 percent), comprised of a $347 million (or 19.6 percent) increase for R&D at NSF, a $133 million increase for DOE's construction of the SSC, and smaller increases for DOE's high energy physics research.
- Funding for energy R&D would rise $199 million, or 7 percent, largely because of the resumption in funding of the Clean Coal Technology program.[2] Within DOE, money would be shifted to solar and renewable energy and conservation (up 35.8 percent and 30.8 percent, respectively) from R&D on nuclear energy (down 53.3 percent) and fossil energy (down 3 percent).
- Natural resources R&D would net an additional $115 million, up 6.6 percent from FY 1993. Double-digit gains were proposed for R&D at the Fish and Wildlife Service and National Park Service, both of which are slated to form the core of the proposed National Biological Survey. Funding would increase by over 7 percent at the National Oceanic and Atmospheric Administration, Environmental Protection Agency, and Forest Service.
- Space R&D at NASA would receive an additional $459 million (up 5.8 percent), with the redesigned space station, Mission to Planet Earth, and Planetary Exploration accounting for most of the gain (up $177.0 million, $125.9 million, and $83.6 million, respectively).
- At $11 billion, health programs would remain the single largest function under nondefense R&D, but the $342 million that would be added for FY 1994 would just be enough to keep pace with inflation.

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[2] In FY 1993, Congress delayed the availability of advance appropriations for the Clean Coal program, for budgetary and technical reasons.

- Agricultural R&D would receive $44 million less in FY 1994 because of a proposed 47 percent cut in R&D facilities. However, funding for the conduct of agricultural research would inch up 1.5 percent over FY 1993 levels.

## Character of Work

The Administration's R&D priorities would affect the character of work being funded by the government. From the aggregated statistics in Table I-5, it appears that the distribution among categories would change very little under the Clinton plan. As Table I-6 shows, however, the trends in defense and nondefense programs are distinctly different.

All types of nondefense R&D would enjoy real growth under the President's request. In contrast to previous administrations, however, the Clinton plan would devote over 45 percent of the new money to applied research (up $0.9 billion or 10.3 percent over FY 1993), and another 22 percent to development ($0.4 billion, up 5.9 percent). These patterns reflect the Administration's emphasis on the economy, infrastructure, and environmental management, which traditionally have involved applied research and development.

The Administration would make NSF the primary beneficiary of the $0.5 billion increase proposed for nondefense basic research (up an average of 4.3 percent from FY 1993). Excluding NSF, funding for nondefense basic research governmentwide would decline in constant dollar terms, despite small increases at NASA and other agencies.

Most of the $145.9 million increase proposed for nondefense facilities would support basic research. Key examples include NSF (up $47.5 million, mostly for the LIGO, GEMINI, and Geosciences facilities), the SSC (up $133 million for equipment and construction), and DOE's construction of an Advanced Neutron Source (up $26.0 million). Offsetting these increases are projected cutbacks in pork-barrel projects (*e.g.*, the Department of Agriculture (USDA) and DOE's basic energy sciences), and a one-year dip in expenditures for upgrading NIST's facilities.

On the defense side, both basic and applied research are projected to decline under the President's budget. The drop in defense-related basic research largely—but not exclusively—reflects budgetary technicalities, such as the elimination of funding for academic earmarks, and the one-time inclusion of the Los Alamos Meson Physics Facility (LAMPF) in DOE's FY 1993 weapons appropriation.

Among the applied research programs recommended for cutbacks are those involving integrated command and control systems, the Defense Nuclear Agency, and certain naval technologies. Most of the items emphasized in defense R&D are classified as development. Less has been requested for defense facilities, especially under DOE's weapons, environmental restoration, and naval reactors programs.

## Agency Highlights

Finally, Table I-7 highlights the R&D budgets for selected agencies. Table II-1 provides this information for all agencies that sponsor R&D, including the split between funding for the conduct of R&D and R&D facilities. Descriptions of agency funding and priorities are presented in Part II of this report. Key findings follow:

DOD ($39.5 billion, up 1.1 percent): Under the request, the budget for the Army's R&D would drop 12.7 percent, but the Navy, Air Force, and Defense Agencies would receive enough new money to maintain or exceed the real, inflation-adjusted FY 1993 level (up 3.2 percent, 4.1 percent, and 3.8 percent, respectively).

DOE Atomic Energy Defense Activities ($3.0 billion, down 7.3 percent): Almost all aspects of DOE's defense R&D would be funded at lower levels, because of the declining demand for nuclear warheads and materials. Among the few items slated for increases in the request are technology transfer (*e.g.*, CRADAs, up 41.2 percent to $198.0 million), verification and control (up 26 percent to $144.4 million), and university science and education (up 10.7 percent to $58.0 million).

DOE General Sciences ($1.6 billion, up 12.8 percent): The $627.6 million proposed for the SSC (up 24.6 percent) assumes fewer dollars for basic research but a $133 million jump in equipment and construction costs. DOE's high energy physics would gain 5.5 percent, but funding for Nuclear Physics R&D would fall 11.6 percent relative to the amount available for all activities in FY1993, including LAMPF.

DOE energy R&D ($2.9 billion, up 7.2 percent): The net change in funding for energy research mostly derives from proposed changes in three programs: Clean Coal Technology (for which the DOE would resume the drawdown of the advance appropriations), civilian technology transfer (for which DOE is seeking nearly $40 million) and Uranium Enrichment (for which no funds were requested pending the transfer of activities to a new government corporation in July 1993). Elsewhere, most of the policy changes offset each other: the increases proposed for R&D on solar, renewables and conservation are roughly comparable to the cutbacks suggested for nuclear and fossil R&D. The $792.6 million request for Basic Energy Sciences (BES) is below last year's level, because eliminating earmarked facilities and creating a separate account for the Advanced Neutron Source would more than offset the 27.6 percent increase proposed for Applied Mathematical Sciences and the 3.2 percent average growth proposed for the other disciplines.

National Institutes of Health ($10.2 billion, up 3.2 percent): The request would grant double-digit increases to the National Library of Medicine (which funds R&D related to high performance computing and communications), the Human Genome Project, and the Office of the Director (which funds R&D on health problems of women and minorities). Reflecting an emphasis on breast cancer and AIDS, the budgets of two institutes—Cancer, and Allergy and Infectious Diseases—would increase by about 8 percent. Most of the others, however, would lose funding in real or nominal terms. Total funding for grants would increase by less than 1 percent under the President's plan.

NASA ($9.5 billion, up 7.9 percent): To limit outyear spending, NASA would redesign the space station; terminate both the National Launch System and the Space Exploration Initiative; restructure the Earth Observing System, Cassini, and AFAX facilities; and delay work on new tracking and data relay systems. Among the programs that would be continued or expanded are the Gravity Probe B and Aeronautics R&D. NASA also raised the prospect of using money saved from the redesign of the space station for New Technology Investments in such areas as aeronautics, earth satellites, deep space programs, and launch vehicle advancement.

NSF ($2.4 billion, up 19.6 percent): Under the President's budget, NSF's R&D programs would begin to recover from the inflation-adjusted loss experienced between FY1992 and FY1993. The Clinton proposal would boost funding for all of the research directorates by an average of 20 percent. About half of the $393.7 million increase proposed for R&D in the coming year would support research related to the five FCCSET[3] research initiatives (*i.e.*, excluding Science and Math Education). As a result, the fastest growth would occur in the Computer Information Sciences and Engineering (up 37.5 percent), Engineering (up 23.7 percent), and Geosciences directorates (up 18.1 percent).

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[3] Includes the following Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) initiatives: Advanced Manufacturing Technology, High Performance Computing and Communications, Advanced Materials and Processing, Biotechnology, and Global Change.

USDA ($1.4 billion, down 2 percent): The steep reduction proposed for R&D facilities (down 44 percent) would more than offset the 2 percent increase requested for the conduct of R&D. Within a relatively stable budget for research at the Cooperative State Research Service (CSRS), funding for competitive grants under the National Research Initiative would go up 33.5 percent, while the Special Grants program would fall 53.1 percent. CSRS has requested no money in FY 1994 for facilities. Similarly, the Agricultural Research Service has proposed a 2.2 percent increase for R&D, but 28.8 percent less for facilities. The Economic Research Service is among the agencies targeted for efficiency reforms, resulting in a proposed 12.7 percent reduction in its R&D funding. The one bright spot is Forest Service R&D, for which the Administration requested an additional 7.7 percent to expand research supporting forest policy decisions.

## PROSPECTS FOR R&D IN THE FY 1994 BUDGET

President Clinton's R&D proposals break the pattern followed by the previous two administrations. In contrast to his predecessors, the President is not proposing dramatic increases for R&D financed by steep cutbacks in other domestic programs. Instead, the Clinton plan would seek a balance between nondefense R&D and other domestic programs, increasing both at a comparable pace. In theory, this could avert the annual tug-of-war between the White House and Congress over fundamental priorities, including funding for science.

Clouding the outlook for favorable action on the R&D request are the caps on discretionary spending. To make up for the $7 billion outlay overrun implicit in the President's budget proposals, appropriators would have to make sharp cuts in unspecified programs. Lawmakers were unwilling to do that to pay for the stimulus package, raising doubts about their willingness to do so for the "investment" package. The "peace dividend" will be of little help, because the Clinton budget already cuts defense spending down to the minimum levels acceptable to congressional leaders.

An alternative (and more likely) solution would be to maintain the status quo, postponing new spending until sometime in the future. In an effort to accommodate the FY 1994 caps, the budget resolution shaved billions of dollars from the outlay levels requested by the President for agriculture, commerce, and transportation, and smaller amounts from space science and technology and international affairs. Health and defense stood out as exceptions to this rule, receiving slightly higher allocations for budget authority and outlays than proposed by the Administration. The outlay target for Natural Resources equalled the President's request.

How these guidelines will translate into appropriations for R&D is impossible to predict. Some of the resolution's targets would be sufficient to accommodate proposed increases for R&D (*e.g.*, defense, health, and environment), while others would not (*e.g.*, commerce, transportation, and to a lesser degree space and science). It is likely that some of the same projects that sparked controversy last year will do the same again, notably the SSC (which the House voted to cancel last year), and the space station (which lawmakers also considered terminating). This year, however, the size of the increase proposed for both "big science" projects is smaller—$0.3 billion combined—and the outyear costs have been capped.

Maintaining R&D at its current inflation-adjusted level may not sound like the proposal of an Administration committed to "revitalizing technology." But if Congress were to approve the FY 1994 request, it would mark progress compared to FY 1993, when R&D lost out to both budget pressures and inflation.

## 2

# Special Analyses

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This chapter provides brief overviews of several important areas of R&D trends. These include federal funding of basic research, federal support for R&D at colleges and universities, and a broadbrush picture of the major national performers and funders of R&D. Tables supporting this discussion are at the end of Part I.

## HIGHLIGHTS

- Basic research support is expected to increase by about $388 million, to $13.9 billion in FY 1994—an increase of 2.9 percent in current dollars but a slight decrease (0.2 percent) after adjusting for inflation. This rate of increase is about the same as that for federal R&D as a whole—3.1 percent in current dollars, and essentially no growth in constant dollars.
- Basic research has been a favored area within overall federal R&D support over the past decade or more. During this period, basic research grew faster than R&D as a whole, and through FY 1993 steadily increased its proportion of an increasing federal R&D support program. That proportion for FY 1994 would remain at 18.4 percent of total federal R&D support, as it was in FY 1993.
- Basic research support is dominated by nondefense work, which accounts for 91 percent. Defense basic research

for FY 1994 would decrease by nearly 10 percent (due largely but not entirely to budgetary technicalities and financial maneuvers). By contrast, nondefense basic research support would increase by more than 4 percent to $12.6 billion.

- NSF in particular and NASA to a lesser extent stand out among the larger agencies in anticipating significant increases in basic research support. The National Institutes of Health (NIH), the largest federal supporter of basic research, expects a very small increase (about half the inflation rate), and only Agriculture, among the remaining larger funding agencies, expects an increase. Most other agencies (for example, Defense, Energy, and Interior) expect decreases in their basic research support.
- Support for research at colleges and universities is expected to increase by about $200 million (1.8 percent), to about $11.2 billion in FY 1994. This would represent a decline in constant dollars of 1.2 percent.
- The federal government's role in the overall national R&D picture, while increasing in an absolute fashion, has been eroding slightly (relative to other sectors) as both a source of R&D funds and as a performer of R&D. Industry continues its dominant role, and colleges and universities have increased their presence as both sources and performers of R&D.

## BASIC RESEARCH

The new Administration's professed strong support for basic research received a good test this year, in the context of extremely tight budgets and a heavy emphasis on technology policy. Although there are many weak spots in the funding picture for basic research, the fact that it was able to hold its own in such a stringent budgetary and political climate may indeed speak well for the Administration's commitment in this area.

Federal support for basic research by agency is shown in Table I-8, with FY 1980 figures as a comparison point. It is important to note that the figures for basic research shown in this table are not actually direct budget proposals, but rather are *estimates* of basic research funding derived from proposed budget data. Agencies present their requests in programmatic terms, and then estimate the amounts that would be spent on different types of R&D based on those requests. Further, interpretations of the definition of basic research are not uniform across agencies, and each agency makes its own distinctions as to type of R&D and estimated spending for each. Consequently, the data reported here are imprecise although generally suggestive in the aggregate.

In the budget proposed for FY 1994, support for basic research would increase from $13.5 billion to roughly $13.9 billion, an increase of $388 million, or 2.9 percent in current dollars and a decrease of 0.2 percent in constant FY 1987 dollars. These rates of increase are comparable to those for R&D overall (3.1 percent in current dollars and zero increase in constant dollars).

Basic research has grown in both absolute and relative terms over the past decade or so. The FY 1994 estimates are about 62 percent higher than in FY 1980 after correcting for inflation—an average *real* growth rate of about 3.5 percent per year compounded. (Against this standard, the proposed increase in basic research estimated for FY 1994, at no real growth from FY 1993, is below the average rate of increase over the past 14 years.) By comparison, the growth of total R&D over the same period since FY 1980 has been 25.6 percent, or an average annual real growth rate of 1.7 percent per year compounded (see Table I-4 or I-5).

In addition, basic research has generally grown over the years in its proportion of total federal R&D support, going from 10.7 percent in FY 1967 (touted as the "golden age" of R&D funding) to 14.2 percent in FY 1980, and settling into the 18 percent range in the past few years. FY 1994's estimates for basic research represent 18.4 percent of total federal R&D support (see Table I-5).

Turning to comparisons of defense and nondefense support, in the past few years somewhat over 90 percent of federally supported basic research has been nondefense, as shown in Table I-6. (In this table, defense includes, in addition to the Department of Defense (DOD), the Department of Energy (DOE) military-related programs.) For FY 1994 federally funded basic research would be 91.0 percent nondefense. Figures in Table I-6 show that defense basic research for FY 1994 (of which 99.8 percent is DOD) would decline by nearly 10 percent. (However, this decline largely reflects the Los Alamos Meson Physics Facility (LAMPF), reverting from a one-time inclusion in DOE's FY 1993 weapons appropriation to FY 1994 coverage under general science and research, as well as the Administration's elimination of funding for certain congressionally initiated "pork barrel" projects from FY 1993). By contrast, nondefense basic research in FY 1994 would increase by 4.3 percent over FY1993 to $12.6 billion. Over the past two years (since FY1992), nondefense basic research funding has increased $821 million, or 6.3 percent in current dollars.

Turning to the agencies (Table I-8), the overall pattern is mixed, with only a few of the larger supporters of basic research receiving increases of any consequence. NIH continues its long-standing role as the largest single federal supporter of basic research. Its estimated total for FY 1994, $5.8 billion, would represent 41.5 percent of all federally supported basic research, down very slightly from its proportion of the previous two years (42.2 percent). NIH's basic research in FY 1994 is expected to increase 1.6 percent in current dollars—a decrease of 1.5 percent in constant dollars. This pattern is lower by 1.3 percent than the overall rate of increase for basic research.

Almost alone among the larger R&D agencies in expecting significant increases in basic research are the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA). NSF would receive a $309 million increase (nearly 18 percent) in basic research funds. NASA's increase would be $120 million, or just over 6 percent in current dollars. NSF's projected increase represents about 80 percent of the total expected increase in federally supported basic research ($388 million). Further, NSF's and NASA's increases together exceed that total. However, since NSF and NASA are handled within the same appropriations subcommittees, it is questionable whether both will sustain the proposed increases in the course of running the congressional budgetary gauntlet.

The only other large R&D-supporting agency expected to receive an increase in basic research support is the Department of Agriculture (USDA), whose basic research would increase by about $27 million (4.6 percent). However, this increase is entirely accounted for by the proposed $33 million increase (34 percent) in the National Research Initiative (NRI) to $130 million. Apart from this increase to the NRI, the rest of USDA basic research would decrease by a total of $6 million, or almost 1 percent in current dollars and about 4 percent after adjusting for inflation.

Smaller agencies anticipating increases in basic research funds include the Commerce Department (over 11 percent), the Environmental Protection Agency (nearly 8 percent), and the Department of Education (6 percent).

Agencies slated for decreases in their basic research funds include DOD (as discussed earlier, down over 5 percent in current dollars), the Department of Energy (down almost 4 percent and discussed further below), the Interior Department (also down over 5 percent), the Smithsonian Institution (down less than 1 percent), the Department of Veterans Affairs (down nearly 14 percent), and the Agency for International Development (down almost 13 percent).

The other significant player in the federal basic research support game is the Department of Energy. DOE would receive a decrease of $69 million, or nearly 4 percent in current dollars and almost 7 percent in constant dollars. The basic research components of the Superconducting Super Collider (SSC) are projected to decrease from $105.8 million to $97.0 million, or 8.3 percent. Declines are also projected for basic research in nuclear and high energy physics. The remaining reductions would result from cutbacks in fossil energy R&D, and unspecified cuts in science programs in energy supply R&D.

Details regarding the specific effects of these trends within each of the agencies can be found in the relevant chapters in Parts II and III of this book.

## COLLEGES AND UNIVERSITIES

Federal support for R&D in colleges and universities has become more visible as a public policy issue, as scientists have become more vocal about the squeeze they are experiencing in trying to secure funding for their research. Data on expected federal support for R&D in colleges and universities are shown in Table I-9. We should emphasize—as we did for basic research above—that these data do not represent direct programmatic decisions, but are after-the-fact estimates of how much funding is likely to go to colleges and universities under program levels contained in the budget request.

Overall, the total of federal R&D support to colleges and universities is expected to increase slightly by 1.8 percent ($203 million) to about $11.2 billion. Converted to constant dollars, this is a decrease of 1.2 percent. Real growth in the two years between FY1992 and FY1994 would be negative, showing a falloff of 2.5 percent under the proposed budget.

Federal agencies fall into three fairly distinct tiers, in terms of their amount of support for R&D in colleges and universities. In the top tier are NIH (with estimated support of $5.9 billion in FY1994), NSF ($1.6 billion), and DOD ($1.3 billion). In the second tier are NASA (estimated at $750 million), DOE ($624 million), and USDA ($440 million). The rest of the agencies fall into the third tier, with the largest being the Department of Education, estimated to provide $112 million in support for R&D at colleges and universities in FY 1994. Breaking out the agencies this way yields some interesting findings.

First, NSF, with an expected increase of $261 million (19 percent), more than accounts for the entire total increase in federal funds going to colleges and universities ($209 million). With NSF removed, the top two of the three tiers have aggregate declines in academically bound funds: the remainder of the first tier, an aggregate decrease of $29 million; and the second tier, an aggregate decrease of $49 million. (The third tier has an aggregate increase of just $7 million.) Of course, there are variations among agencies within each of the tiers, and we turn to those next.

Within the top tier apart from NSF, the National Institutes of Health (NIH) and its parent department, Health and Human Services, would receive a more modest increase of less than 2 percent. However, NIH would still furnish 52.5 percent of all federal funds going for R&D in colleges and universities, down slightly from 54.6 percent two years earlier in FY1992. DOD's support in this area would decrease by $119 million (8.2 percent in current dollars and 11 percent in constant dollars), but again as in basic research some component of this decrease is probably due to congressional pork-barrel items not being funded in the Administration's budget request for FY 1994.

Within the second tier, NASA's support for R&D at colleges and universities would increase by $24 million or just over 3 percent in current dollars (0.2 percent in constant dollars). The USDA's support in this area would increase very slightly (by $3 million, or less than 1 percent in current dollars and a decrease of just over 2 percent in constant dollars). However, these small increases would be more than offset by the expected drop of $76 million (nearly 11 percent) in DOE's support going to colleges and universities.

Below these two tiers are several other smaller agencies that present a mixed picture in terms of R&D support in colleges and universities. Agencies anticipating small increases in this area include Education (nearly 6 percent) and EPA (just over 6 percent). Agencies slated for decreases include Interior (6 percent) and AID (6 percent).

## NATIONAL PATTERNS OF R&D

Table I-10 shows the national patterns of R&D spending estimated by NSF for 1992, arraying sources of funds against R&D performers. These estimates show that total national spending for R&D in 1992 was $157.4 billion, a very slight increase in constant dollars (0.7 percent) over the two-year period 1990-1992.

These data show federal spending accounting for $68.2 billion, or 43.3 percent, of national R&D spending. Table I-11 shows that this share has fallen from 57 percent in 1970, with the largest part of this relative decline occurring in the 1970s. Industry in 1992 spent about $81.1 billion on R&D, or 51.5 percent of national totals. This share is up somewhat from 49.4 percent in 1980, but up markedly from 40 percent in 1970. Again, the biggest relative shift came in the 1970s. In that decade, federal spending for R&D doubled in current dollars, but industry spending tripled.

Funding of R&D by (a) colleges and universities and (b) nonprofit organizations is still relatively small (3.3 percent and 1.8 percent of total national R&D spending, respectively). However, these were the fastest-growing segments over the past two years, with each showing about 13-14 percent real growth in this period. Colleges and universities in particular have increased their R&D support, both relatively and absolutely (see Table I-11). Since 1970 they have more than tripled their R&D support in *real* terms, and have gone from providing 1.8 percent of the national R&D support to 3.3 percent.

Among performers of the nation's R&D (see Table I-12), the primary performer continues to be industry, which performs almost all (97.5 percent) of the R&D that it supports, plus 46 percent of all federally supported R&D. Its total of R&D performance is $110.3 billion, or 70.1 percent of total national R&D. This share has changed relatively little since 1970. Colleges and universities performed $19 billion of R&D in 1992, which represents 12.1 percent of the national total. This sector, too, has increased its share over the past two decades, rising from 8.9 percent in 1970 and 9.7 percent in 1980. The sector that has declined, relatively speaking, in volume of R&D performed over the past two decades is the federal government. Federal support for its own R&D operations has increased, to be sure, even in real terms, but its proportion of the national R&D effort has fallen from almost 16 percent in 1970 to about 11 percent in 1991.

Finally, a breakdown of the sources of R&D support for college and university performers (Table I-10) shows that 57 percent of their funds come from the federal government, with another 28 percent supported by colleges and universities themselves. Industrial support for R&D performed by colleges and universities—the subject of much attention for over a decade—continues to grow at a significant pace, over 11 percent in constant dollars over the past two years. It was estimated at $1.35 billion in 1991. However, it is still the smallest source of R&D funds for colleges and universities, even trailing support from nonprofit institutions. This $1.35 billion figure represents 1.7 percent of all R&D supported by industry.

# 3

# R&D in Industry

*Charles F. Larson, IRI*

## INTRODUCTION

This chapter will briefly outline forecasts for industrial R&D spending in the United States during the calendar year 1993, will describe some recent trends in R&D management, will indicate current R&D spending plans in other countries, and will summarize results of the Industrial Research Institute's (IRI) annual R&D trends forecast.

## A CURRENT PERSPECTIVE ON INDUSTRIAL R&D

Industry funding of R&D in the United States will reach another all-time high, in current dollars, during 1993. Battelle forecasts that this funding will be slightly more than $83 billion, an increase of some $2 billion, or only 2.4 percent, over the $81.1 billion estimated to have been spent in 1992. In constant dollars, the $83 billion for 1993 is virtually the same as that for 1992, and only 2.6 percent higher than it was in 1990. Thus, real growth has been less than 1 percent per year in recent years.

If one includes government funding of R&D in industry, from DOD, DOE, NASA, and other agencies, Battelle estimates that industry will perform $112.7 billion of R&D in 1993, an increase of 2.2 percent over the $110.3 billion estimated for 1992. Industry is responsible for about 73 percent of all R&D carried out in the United States, and funds slightly more than 51 percent of the total. Nearly three-quarters (73 percent) of the industrial R&D effort is directed toward development activities, such as product and process prototypes, design, testing, and pilot-plant operations. Nearly one-quarter is spent on exploratory, or applied research, directed toward gaining new knowledge related to existing or planned products, processes, or services. About 5 percent of industrial R&D is allocated for basic, or fundamental research.

Industrial R&D is carried out by nearly 750,000 scientists, engineers, technicians, information specialists, and managers in over 13,000 laboratories across the country. It is by far the most elaborate and sophisticated research enterprise in the world, with an estimated capital investment of over $100 billion. Many companies have central, or corporate, laboratories in addition to several divisional laboratories. The trend in recent years has been to reduce the size of the central laboratory and to increase the size of divisional laboratories in order to bring R&D closer to manufacturing, marketing, and the company's customers.

Although industrial R&D is carried out by thousands of companies in the United States, a large part of the effort is concentrated in only a few hundred organizations, primarily from the manufacturing sector. For example, just the top 10 R&D spenders, including General Motors, IBM, Ford, and AT&T, account for nearly one-quarter of the total annual investment in industrial R&D, while the top 100 R&D spenders account for nearly three-quarters of the total.

Industrial R&D in the United States began in the nineteenth century. The focus at that time was on agriculture and mechanics. In the twentieth century, laboratories were created to develop new knowledge in chemistry, physics, metallurgy, and other basic sciences. By 1920, about $29 million was being spent on scientific research by industry. This spending grew to $166 million by 1930 and to $234 million by 1940. During this time, government spending on R&D was considerably less, by a large fraction. By 1942, however, the federal government's R&D budget was rising rapidly, and went from $69 million in 1940 to some $720 million in 1944. Most of these government funds were spent in industrial and university laboratories. Government funding of R&D continued to be considerably larger, on the order of two to three times that of industry, into the 1960s. In the late 1970s, industrial R&D began to grow rapidly and by 1980 exceeded the level of government R&D support for the first time in nearly 40 years. Today the ratio for total annual investment in R&D is 51 percent industry, 43 percent government.

## RECENT TRENDS IN R&D MANAGEMENT

The primary product of industrial R&D is information, or knowledge, and the usual customer is in other parts of the company, such as design engineering, production, and marketing. This information can contribute to and actually be the key factor in stimulating innovation, that is, the process of bringing new products, processes, systems, or services to the marketplace.

With R&D spending showing little or no real growth in many large industrial companies, and actual declines in some others, a great deal of effort is being focused on making the R&D function within companies more responsive as well as more productive. "Do more with less" has become the current expectation. Major R&D cuts, such as IBM's recent $1 billion, or 20 percent, reduction can produce serious morale and productivity problems with research personnel. Cuts can also interrupt promising projects and can eliminate key personnel as well as long-range, high-risk studies that have the potential for producing very high returns on investment.

The current economic climate for industrial R&D has spawned acute interest in improving the quality of the output of R&D–knowledge–as well as reducing the time required to produce it. A survey of the IRI membership last spring showed that cycle-time reduction was one of the major challenges being faced by research directors. A six-month's lead time in the market can be crucial to commercial success.

Other challenges included the alignment of technology strategy with long-term business strategy; team building; coordination of corporate functions and information systems for integration of the enterprise (parallel processing of innovation); management of human resources, particularly under slow economic conditions; transfer of technology from internal and external sources; balancing long-term/short-term objectives/strategies for R&D; and techniques of measuring/benchmarking functions in the R&D process. Overlaid on all of these challenges is the commercialization of new technology and the process of "globalizing" R&D within most larger companies, that is, coordinating the efforts of R&D laboratories around the world to compete effectively in all markets.

## INDUSTRIAL R&D SPENDING TRENDS IN OTHER COUNTRIES

Data on company R&D spending in other countries are difficult to obtain and usually out-of-date by several years. The National Science Foundation's (NSF) Science Resources Studies Division had, until 1991, published such data with a lag period of only two years.

These figures were particularly useful for the trends indicated in each country. Direct comparisons of national spending have been tenuous because of differences in the cost of performing research in various locations around the world, in the rate of inflation, and in currency fluctuations. In order to level these differences, NSF would convert foreign expenditures to U.S. dollar equivalents using Purchasing Power Parity exchange rates published by OECD. NSF data for 1989 showed that industrial R&D expenditures in the United States exceeded those of Japan, Germany, France, the UK, and Canada combined. Indeed, it is estimated that the U.S. expenditure on industrial R&D is about one-third of the entire world's *total* spending on R&D.

The Japan Economic Institute reported (No. 36A) in 1991 that company funding of R&D in Japan, in current figures, had increased 10.2 percent in 1988 and 13.0 percent in 1989. Data for 1990 and 1991 will probably also show double-digit growth. This strong growth in Japanese industrial R&D was abruptly interrupted by the 1992-93 economic slowdown in Japan. In many cases, company R&D budgets were not increased, or were actually cut. A recent survey of the four IRI member companies in Japan revealed that three companies will have a small increase this year over last, on the order of 3 to 6 percent. In the fourth company, R&D will decline for the first time. However, all four of the companies expect an increase in their budgets next year.

Of seventeen IRI member companies headquartered in Europe, eight have higher R&D budgets this year, with five companies reporting increases of 7 percent or more. Two companies are cutting their budgets by 15 percent, while four are cutting by 2 to 5 percent. The aggregate change for the 17 companies that responded was an increase of less than 1 percent. Eight of the 17 companies plan to increase their R&D spending next year, whereas nine see no change or a further decline.

Two of the four IRI members in Canada increased their 1993 R&D budgets. The third had a sizable decrease, while the fourth had no change. Only one of the four Canadian companies expected an increase in spending next year.

Based on this relatively small sample of companies, it seems that only in Japan is the outlook for R&D spending in 1994 somewhat more optimistic than it is for 1993.

## 1993 PROJECTIONS FOR INDUSTRIAL R&D IN THE UNITED STATES

IRI's annual trends survey of industrial R&D[1] was sent to 251 member companies in the United States, with 141 responses. Respondents were asked to estimate relative changes in levels between 1992 and 1993 in the following categories: Expenditures, Effort Allocation, and Personnel Trends.

As in previous years, a scale of 1-5 was used:
1 = "significantly less" (-5 percent or less)
2 = "slightly less" (0 to -5 percent)
3 = "approximately the same" (1 to 5 percent more)
4 = "slightly more" (6 to 10 percent)
5 = "significantly more" (more than 10 percent)

The results showed continued pessimism in most categories, indicating that the recession for industrial R&D in the United States would continue for at least another year.

## Highlights of the survey follow:

- 28 percent expected to decrease their total R&D expenditures from 1992, in contrast to 19 percent in 1991 and 16 percent in 1990.
- 24 percent expected to increase their total R&D expenditures over 1992, the same as in 1991 but down from 41 percent in 1990.
- 36 percent expected to decrease their capital spending for R&D (34 percent in 1991; 32 percent in 1990).
- 20 percent expected to increase their capital spending for R&D (21 percent in 1991; down from 27 percent in 1990).
- Only 10 percent expected to increase hiring of new graduates, while 40 percent expected a decrease (in 1991, 13 percent expected an increase; in 1990, 21 percent).
- 84 percent expected their R&D professional staffing level to remain unchanged or to drop from 1992 levels (94 percent in 1991; 71 percent in 1990).
- 18 percent expected to decrease grants and contracts for university research (23 percent in 1991; 21 percent in 1990).

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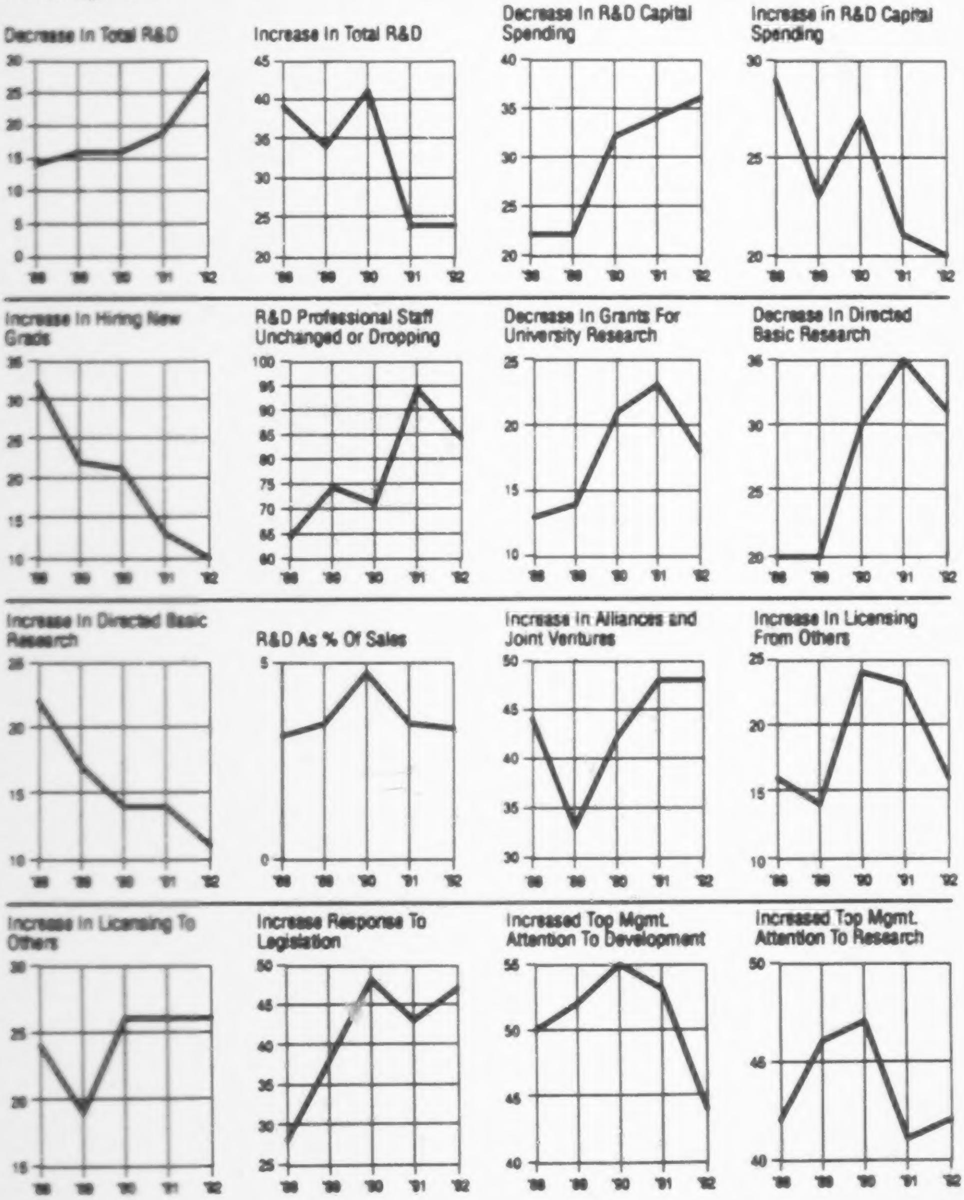
1 "Industrial Research Institute's Annual R&D Trends Survey," RESEARCH TECHNOLOGY MANAGEMENT, January-February 1993, pp. 12–14.

- The proportion of resources allocated to directed basic research was expected to decrease at 31 percent of the companies while increasing at only 11 percent (in both 1991 and 1990, 14 percent expected in increase).
- Total R&D as a percent of sales was expected to decrease from 3.4 percent to 3.3 percent.

The accompanying graphs illustrate the five-year trends in each of the responses noted above.

*What Respondents To R&D Trends Survey Predicted: 1988-1992*

*In % of respondents*



Other major results from this year's survey were generally similar to the ones from last year.

### 1. The past two years' surveys show continuing interest in cooperative research.

- 48 percent anticipated an increase in participation in alliances and joint ventures for R&D (48 percent in 1991; 42 percent in 1990).
- 16 percent expected to increase licensing from others (down from 23 percent in 1991; 24 percent in 1990).
- 26 percent expected to increase licensing to others (the same in 1991 and 1990).

*Table 1-Survey Questionnaire Results*

| **Expected Changes in 1993 Compared with 1992 Experience** | **Relative Change (No. of Responses)** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **NA** | **1** | **2** | **3** | **4** | **5** | **NR** |
| ***Expenditures*** | | | | | | | |
| **1.** Total R&D expenditures | 1 | 17 | 22 | 67 | 28 | 6 | 0 |
| **2.** Ratio of direct salaries and wages to other direct R&D costs | 4 | 1 | 17 | 105 | 13 | 1 | 0 |
| **3.** Capital spending for R&D operations | 1 | 18 | 33 | 61 | 17 | 11 | 0 |
| **4.** Subcontracting R&D to outside commercial organizations | 5 | 7 | 9 | 88 | 21 | 2 | 9 |
| **5.** Grants, contracts, etc. for university R&D | 6 | 8 | 23 | 82 | 15 | 1 | 6 |
| ***Effort Allocation*** | | | | | | | |
| **6.** Relative distribution of R&D costs | | | | | | | |
| **a)** Support of existing business | 0 | 4 | 26 | 77 | 31 | 3 | 0 |
| **b)** Directed basic research* | 4 | 9 | 31 | 75 | 14 | 0 | 8 |
| **c)** New-business projects | 1 | 10 | 18 | 65 | 39 | 7 | 1 |
| **7.** Ratio of non-centralized (e.g., divisional) to centralized corporate R&D efforts | 10 | 3 | 8 | 78 | 12 | 6 | 24 |
| **8.** Outside-customer technical-service efforts relative to total R&D (in time or dollars) | 5 | 1 | 8 | 87 | 28 | 2 | 10 |
| **9.** R&D efforts in response to existing or proposed legislation, standards, or other governmental rules (in time or dollars) | 2 | 0 | 7 | 65 | 57 | 6 | 4 |
| ***Personnel Trends*** | | | | | | | |
| **10.** R&D professional personnel level | 0 | 13 | 28 | 78 | 21 | 1 | 0 |
| **11.** Hiring new graduates | 3 | 14 | 43 | 64 | 14 | 0 | 3 |
| **12.** Top management attention to *Research* on longer term or strategic issues | 0 | 5 | 11 | 64 | 44 | 15 | 2 |
| **13.** Top management attention to *Development* | 0 | 1 | 6 | 72 | 47 | 15 | 0 |
| **14.** Participation in consortia for pre-competitive university research | 11 | 8 | 12 | 71 | 18 | 2 | 19 |
| **15.** Participation in alliances and joint R&D ventures | 6 | 2 | 5 | 59 | 54 | 8 | 7 |
| **16.** Licensing technology from others (dollar volume) | 12 | 1 | 10 | 90 | 17 | 2 | 9 |
| **17.** Licensing technology to others (dollar volume) | 10 | 1 | 8 | 81 | 27 | 5 | 9 |
| **18.** Extent of government financial support of R&D | 19 | 4 | 10 | 50 | 20 | 3 | 35 |
| **19.** Contacts with Federal laboratories | 15 | 2 | 9 | 46 | 36 | 8 | 25 |
| **20.** Overhead costs | 3 | 7 | 32 | 88 | 10 | 0 | 1 |
| ***Calculated Data*** | | | | | | | |
| **21.** R&D expenditures as a percent of sales: | 3.4% in 1992; 3.3% anticipated for 1993 | | | | | | |

* Research whose outcome may be unknown at the time the work is undertaken but where there is a reasonable expectation that the findings will be valuable to the supporting organization.

**2. R&D efforts in response to regulations are increasing steadily.**

- 47 percent expected to increase efforts in response to existing or proposed rules (up from 43 percent in 1991 and 38 percent in 1989).

**3. However, top management attention to R&D was not expected to be as strong as it has in recent years.**

- 44 percent expected more top management attention to Development (53 percent in 1991; 55 percent in 1990).
- 42 percent expected increased top management attention to Research on longer-term or strategic issues (41 percent in 1991; 47 percent in 1990).

Numerical results of the 1993 trends forecast are shown in Table 1.

## CONCLUSIONS

Industrial R&D in the United States is a vibrant, productive enterprise, but aggregate funding is growing at an extremely slow pace. This situation is similar to that in most other countries, due to a squeeze on corporate profits and slow economic conditions in recent years. To offset these problems, R&D as well as other corporate functions have implemented a variety of new techniques to become more productive, to reduce cycle times, to improve the quality of their work, and ultimately to enhance their effectiveness. The outlook for strong growth in R&D budgets is not yet optimistic and will remain weak until corporate profits are again strong and sustained.

# 4

# Science, Mathematics, and Technology Education and Human Resources in the FY 1994 Budget

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## HIGHLIGHTS

- The total amount requested for FY 1994 in support of science, mathematics, engineering, and technology education (SMETE) programs is $2.334 billion.
- Together, the request of the National Science Foundation (NSF) for precollege programs, which is $351.97 million, and the request of the Department of Education (ED), which includes the $252.7 million Eisenhower Mathematics and Science Education State Grants, comprise over 80 percent of the total FY 1994 request for precollege science, mathematics, and technology (SMT) education programs.

## INTRODUCTION

The President's budget for FY 1994 requests $2.334 billion in support of programs in SMETE. This figure represents the combined activities of eleven of the sixteen agencies that participate in the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) Committee on Education and Human Resources (CEHR). The FCCSET analysis forms the framework for the budget presentation given here, while the details for the agencies and departments are drawn from information provided either within individual agency budget submissions or from staff members. The FCCSET-CEHR analysis is restricted to programs that Congress has mandated for SMETE or that the agencies manage expressly as education-related. The mathematics and science support provided by education programs like Chapter 1 and magnet schools is not included in the FCCSET-CEHR numbers. Also absent from the FCCSET-CEHR numbers is the amount of federal support available for research assistantships for graduate students; this funding appears in research and development figures rather than in science, mathematics, and technology education. As a result, this analysis probably underestimates the amount of federal funding available for SMT education and human development.

The Bush Administration requested $2.1 billion for SMETE in FY 1993. The estimates for actual expenditures for SMETE for FY 1993 were not yet available at the time of this publication from the FCCSET-CEHR crosscut.

The briefing document on the FCCSET education initiative points out the varying levels of agency participation as to amount and target educational levels. For example, over 80 percent of the support for all precollege programs comes from NSF and ED. On the other hand, the Department of Defense (DOD), NSF, and Health and Human Services (HHS) provide almost 80 percent of the support for undergraduate programs. Additionally, DOD, NSF, and HHS account for 90 percent of the graduate funding. The analysis also indicates that the Department of the Interior (DOI), NSF HHS, and the Smithsonian Institution (SI) provide primary support for public understanding of science initiatives.

With the first budget from the Clinton Administration, we look beyond the surface to determine the broad policy outlines that might become trends. To the extent that the FY 1994 budget for SMETE represents a continuation of the overall strategic vision developed through the established FCCSET mechanism, it reflects the grounding of these programs in the National Education Goals, the implementation of which was led by then-President Bush and then-Governor—now President—Clinton. To the extent that this represents a transitional budget, we would expect the new Administration to enhance key program components and pursue new directions. These expectations become manifest in the budget outline.

For example, systemic reform, educational technologies, and underrepresented groups will likely be emphasized greatly. Technical worker training will probably emerge as a major area of emphasis over the next several years as well, and with this focus, a greater role for the Department of Labor (DOL) is likely to develop within FCCSET-CEHR.

The greater focus on systemic reform this year is evidenced by the increase in NSF's funding request for programs of this sort as well as by the President's legislative proposal *Goals 2000: Educate America Act*, which calls for comprehensive, systemic reform, including support for setting goals and developing standards, encouraging the involvement and support of parents and families, enhancing instruction and curriculum quality, restructuring schools, and facilitating students' transitions from school to college or work. The President has requested $420 million for this program.

Initially, FCCSET's main service was to provide a crosscut, a comparative analysis of the amount of funding each federal agency requested for SMT education. More recently, however, FCCSET is able to use the information it collects to solve problems across agencies, in keeping with the apparent trend toward systemic reform. Refer to Table 1 for funding figures for FCCSET education initiatives in FY 1994.

## NATIONAL SCIENCE FOUNDATION (NSF)

According to *FCCSET Initiatives in the FY 1994 Budget*, NSF has requested $622 million in support of FCCSET initiatives. Of this amount, $509.8 million would be provided by NSF's Education and Human Resources (EHR) activities for the FCCSET Math and Science Education Initiative. This support from EHR represents a $67.3 million or 15.2 percent increase over the FY 1993 estimate of $442.5 million. Not included in the FCCSET figures are the Experimental Program to Stimulate Competitive Research (EPSCoR) and programs for women faculty and research in minority institutions. The FY 1994 current estimate for these programs is $46.3 million, a $1.3 million increase over the FY 1993 current estimate of $45.0 million. Congress mandated increases for systemic reform activities such as EPSCoR and a new Urban Systems initiative and for graduate education and research development, especially for support of graduate research traineeships. The fact that the FY 1993 current levels for these areas exceed the FY 1993 requests demonstrates the Congressional emphasis on these areas. The FY 1993 revised current plan of $85.7 million for systemic reform is $9.7 million or 12.8 percent higher than the FY 1993 request of $76.0 million. This focus on systemic strategies is in keeping with the President's proposed *Goals 2000: Educate America Act*, the $420 million program emphasizing systemic reform in schools nationwide. The FY 1993 current revised plan of $62.5 million for graduate education and research development is $4.6 million or 7.9 percent higher than the FY 1993 request of $57.9 million. The FY 1994 request of $65.9 million for human resource development, which supports activities that increase the presence of underrepresented groups such as minorities, women, and people with disabilities in scientific, technological, and educational fields, represents a $17 million or 34.8 percent increase over the FY 1993 revised current plan of $48.9 million. Almost 70 percent of NSF's Math and Science Education Initiative budget is aimed at the precollege level. Refer to Table 2 for EHR's participation in FCCSET initiatives across educational levels.

Of the approximately $122 million targeted for FCCSET programs other than those of EHR's Math and Science Education Initiative, $30.9 million supports math and science education within Mathematical and Physical Sciences (MPS), $18.4 million supports engineering education within Engineering Education Centers (EEC), which is coordinated with EHR, $11.1 million goes to math and science education within Computer and Information Science and Engineering (CISE), $7.3 million supports math and science education within Geosciences (GEO), and $3.6 million supports math and science education within Social, Behavioral & Economic Sciences (SBE).

## DEPARTMENT OF EDUCATION (ED)

For FY1994, the ED total request is $30.7 billion, $356 million of which is targeted for FCCSET initiatives. Most of the FCCSET funding, $252.7 million, is slated for the Eisenhower Mathematics and Science Education State Grants Program, the federal government's largest single program in support of National Education Goal 4: to make American students first in the world in science and mathematics. This allotment represents a $6.7 million or 2.7 percent increase over the FY 1993 current level of $246 million. Other notable programs include the National Science Scholars program, which supports the national goal of increasing science and mathematics achievement by recognizing graduating high school students who have excelled in SMT education. The FY1994 request of $6 million represents a $1.5 million or 33.3 percent increase over the FY 1993 level of $4.5 million, which would support 3,373 awards to new and continuing recipients, as opposed to 2,489 awards for 1993. The Eisenhower Mathematics and Science Education Regional Consortia, located in 10 regions throughout the country, disseminate information on exemplary science and mathematics instructional materials and provide technical assistance in the use of improved teaching methods and assessment tools. The $0.9 million decrease from the FY 1993 current level of $13.6 million to the FY1994 request of $12.7 million reflects the statutorily required increase in non-federal project support in the third year.

The Minority Science Improvement program provides financial assistance to improve science and engineering programs at postsecondary institutions with predominantly minority enrollments. The program is designed to improve the ability of such institutions to develop and maintain quality science education programs and to help increase the representation of minorities in science and engineering careers. The FY 1994 request of $5.9 million equals the current FY 1993 level.

An increase of $35.7 million is requested for the National Assessment of Educational Progress (NAEP). The 122 percent increase in the FY 1994 request over the FY 1993 level of $29.3 million would support national assessments to be conducted in 1994 in three subjects in grades four, eight, and twelve. The budget request was submitted based on the assumption that additional state-level assessments will be authorized by Congress to be conducted in one class in 1994 in grades four, eight, and twelve. This is in keeping with the recommendation of the National Academy of Education that additional state trials, including grade twelve, be conducted before state assessments are authorized on a permanent basis. Given ED's strong interest in improving the quality of SMT education, it is likely that SMT subjects will be among those assessed.

Although this discussion is primarily confined to provisions in the FY 1994 budget for SMT education, the subject of systemic education reform is relevant to the discussion. Much of the funding for systemic education reform is found in the *Goals 2000: Educate America Act* and Chapter 1 programs. Insofar as they focus on making adequate educational provisions for all students by creating a national framework for education reform and targeting educationally disadvantaged students, respectively, these programs facilitate the achievement of the specific SMT goals of increasing proficiency in these areas. This is so because the ability to affect the target populations will require a focus on high-level skills. The new School-to-Work Transition education reform initiative, for which the Administration has requested $270 million (divided evenly between ED and DOL), is also applicable to this discussion because it intends to provide a framework for the practical application of science, mathematics, and technology skills by helping students make a successful transition from school to the workplace.

## DEPARTMENT OF AGRICULTURE (USDA)

While USDA has requested $24 million for FCCSET education initiatives, the nature of many USDA programs that are not specifically earmarked for these initiatives causes them to fall into the category of

SMT education support as well. Programs that support SMT education within USDA include Higher Education ($9.0 million) and 1890 Capacity Building Grants ($11.5 million) programs; funds for these programs are requested for continuation of successful ongoing programs that support graduate education in the food and agricultural sciences. The implementation of a Minority Scholars Program is also proposed to encourage the development of minority talent in the agricultural and related sciences. For the Cooperative Forestry Program, the university component of a USDA initiative to enhance forestry research, USDA has requested $28.0 million for FY 1994, a $9.0 million increase over the FY 1993 level of $18.5 million. The additional funding will help USDA develop sound policies for forest management and production, including regional ecosystem management.

## DEPARTMENT OF COMMERCE (DOC)

In FY1994 DOC requested $5.9 million to support fellows participating in the National Institute of Standards and Technology/National Research Council Postdoctoral Research Associateships Program.

## DEPARTMENT OF DEFENSE (DOD)

DOD's total request for FCCSET education programs for FY1994 is $539 million. Almost 70 percent, or $369 million, of this amount is for graduate programs. The undergraduate request is $145 million, and $26 million is requested for precollege support.

## DEPARTMENT OF ENERGY (DOE)

DOE's SMT education programs request for FY 1994 is $128.4 million, in keeping with FCCSET-CEHR priorities. The precollege portion of the request is $32.3 million, which is an 18 percent increase over FY 1992. The public science literacy education request is $4.3 million. A FCCSET-CEHR initiative introduced in FY1993 and implemented by DOE through the Office of Energy Research is a multiagency program to provide intensive training opportunities for precollege teachers at federal laboratories. The request for this initiative is $4.3 million.

## DEPARTMENT OF HEALTH AND HUMAN SERVICES (HHS)

HHS's total FCCSET initiatives request for FY 1994 is $464 million, according to *FCCSET Initiatives in the FY 1994 Budget*. Although much of its funding supports graduate research in the biomedical and behavioral sciences, HHS is placing an increasing emphasis on public science literacy and precollege intervention. Through its Public Health Service (PHS) agencies, especially the National Institutes of Health (NIH), HHS seeks to increase the public's understanding of the biomedical and behavioral sciences, to expose precollege and college students to research in these areas, and to increase the opportunities for and recruitment of disadvantaged and underrepresented populations in these fields. Ongoing programs that support these efforts include the Public Science Literacy program, which uses a variety of media and methods to increase the scientific understanding of schoolchildren, parents, teachers, community leaders, and others. Also supporting these goals are the Adopt-a-School programs, which involve interaction among precollege students and scientists and other role models, during which the scientists provide information on careers in the biomedical sciences. The Minority Access to Research Careers (MARC) program supports these initiatives as well. MARC seeks to increase the resources and number of minority biomedical scientists, to improve science and research opportunities at institutions with high enrollments of minorities, and to prepare students for biomedical careers.

## DEPARTMENT OF THE INTERIOR (DOI)

DOI requested $90 million for FCCSET education programs in FY1994. Of this amount, $9.5 million would support the U.S. Geological Survey (USGS) Joint Education Initiative (JEDI), a precollege program that involves developing precollege educational materials that incorporate actual databases and software used by professional earth scientists. Also, within the DOI National Park Service (NPS), interpretation and education activities foster appreciation and understanding of park resources. The "Parks as Classrooms" program, which will spend approximately $0.8 million in FY 1993, funds resource-based activities that allow children, teachers, and adults to use park facilities to enhance their understanding of critical resource issues and support programs at schools and community facilities near parks. The Servicewide Interpretive Media Program, coordinated by the Harpers Ferry Center in West Virginia, provides media specific to each park site. Along with audiovisual programs and films, the center publishes highly detailed maps, educational charts, handbooks, site bulletins, posters, and park folders as part of the program. In FY1994, NPS has requested $12.1 million for the media program.

## ENVIRONMENTAL PROTECTION AGENCY (EPA)

For FY 1994, EPA requested $10 million for FCCSET education programs. EPA supports FCCSET's Mathematics and Science Education efforts with several programs that provide financial assistance, opportunities, and facilities to stimulate students' interests in environmental sciences and enable them to apply these interests. Some of these programs focus on minorities. The Minority Institutions Student Fellowship Program (MISFP) plans to award fellowships to undergraduates at minority institutions. The Minority Institutions Summer Internship Program (MISIP) plans to enable fellowship recipients to apply their newly acquired skills to real-world environmental problems via a three-month summer internship at an EPA facility. The Minority Academic Institutions Graduate Traineeship Program (MAIGTP) will provide financial assistance to minority students seeking advanced degrees. The Progression Education Program will award traineeships that provide minority and other culturally diverse undergraduate and graduate students with an opportunity to participate in significant laboratory research that could lead to employment in the science and engineering fields.

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA's FY1994 budget request for FCCSET education initiatives is $84 million. Much of its funding will be allocated for undergraduate and graduate programs, including $23.2 million to support human resources capacity-building through funding of research in minority institutions. This will be distributed among Historically Black Colleges and Universities (HBCUs), other minority universities, and graduate and undergraduate student researchers programs with a focus on underrepresented minorities. The Space Grant College and Fellowship program request is $14.5 million. This program involves the participation of Designated Space Grant Colleges/Consortia, institutions that are heavily involved in extensive NASA research and related public service, and that offer advanced study in aerospace fields.

## SMITHSONIAN INSTITUTION (SI)

SI's budget request includes $10 million for FCCSET education programs. Individual groups within SI, such as the Smithsonian Astrophysical Observatory (SAO) Project STAR (Science Teaching through its Astronomical Roots), the Smithsonian Tropical Research Institute (STRI), the Smithsonian Environmental Research Center

(SERC), the National Zoological Park (NZP), and the National Air and Space Education Outreach Activities are committed to science and mathematics education. SI's Academic and Educational Programs request of $0.78 million for precollege programs in FY 1994 is the same as the FY 1993 estimate. Academic and Educational Programs consists of two offices: the Office of Elementary and Secondary Education (OESE) and the National Science Resources Center (NSRC). OESE utilizes SI resources to reach all members of the precollege community and represents SI on the FCCSET-CEHR. NSRC is a joint effort of SI and the National Academy of Sciences to improve the teaching of science in the nation's schools.

## CONCLUSION

This year's budget request demonstrates an interesting juxtaposition of innovation and tradition. Given the presence of a new Administration, we can expect to see steps in new directions toward strengthening SMT education nationwide. Simultaneously, these steps will be rooted in a tradition of commitment to improving American education at the precollege level by focusing on state and locally delivered reform efforts and at higher levels by targeting activity within colleges and universities. The retention of the FCCSET-CEHR mechanism, at least for the time being, and the focus of reform using the National Education Goals represent a process for developing a coordinated, coherent response to the nation's education needs that can withstand changes in Administrations.

An important aspect of the education initiatives for which the Clinton Administration has requested support this year involves a strong emphasis on inclusion. Systemic reform initiatives call for efforts to facilitate broad, standards-driven changes and alignment of activities in many agencies. In short, there seems to be a trend toward comprehensive, seamless action in support of education reform on every level. Perhaps this trend could be strengthened further with the coordination of agency requests for funding of specific research, staffing, and human resources development needs. Funding to meet these needs could positively affect SMT education, because their very goals, conducting worthwhile, quality research, recruiting and retaining competent employees, and educating the next generation of scientists and engineers, necessitate SMT education reform.

It is not possible to determine a true picture of the amount of federal funding available for SMT education. This is because many initiatives that positively affect SMT education are not defined as such by FCCSET-CEHR. The narrow definitions set out by FCCSET-CEHR as to what constitutes a FCCSET-CEHR program may obscure opportunities to leverage other monies for SMT education and to encourage new SMT education initiatives. To realize fully the programming and funding potential for SMT education reform, FCCSET-CEHR must broaden the definitions of funding available to support reform. Creative mechanisms must be employed to get more reform out of the existing level of resources and more effectively to leverage state and local funding to support SMT education and reform.

**Table 1.** Funding for FCCSET Education Initiatives, FY 1994 (Budget Authority in millions of dollars)

| Agency | Funding |
|---:|---:|
| Total | $2,334 |
| DOD | 539 |
| DOI | 90 |
| USDA | 24 |
| DOC | 6 |
| HHS | 464 |
| DOT | — |
| DOE | 128 |
| ED | 356 |
| DVA | — |
| EPA | 10 |
| NASA | 84 |
| NSF | 622 |
| AID* | — |
| SI* | 10 |

* Is not a member of full FCCSET (AID = Agency for International Development; SI = Smithsonian Institution).

Source: *FCCSET Initiatives in the FY 1994 Budget*, pg. 4.

**Table 2.** EHR Participation (in Millions) in FCCSET Initiatives across Educational Levels - National Science Foundation

| Education Level | FY 1993 | FY 1994 | Change FY 1993 vs. FY 1994 |
|---|---|---|---|
| Precollege | $309.22 | $351.97 | $42.75 |
| Undergraduate | 72.42 | 93.02 | 20.60 |
| Graduate | 54.79 | 58.79 | 4.00 |
| Public Science Literacy | 6.03 | 6.03 | 0.00 |
| **Total, Math & Science Education Initiative** | **$442.46** | **$509.81** | **$67.35** |
| Other** | 45.04 | 46.23 | 1.25 |
| **Total, EHR** | **$487.50** | **$556.10** | **$68.60** |

* Does not include additional $24.97 million unobligated balance from FY 1992.

** Includes EPSCoR, programs for women faculty and minority institution research.

Source: NSF budget request, FY 1994.

# Overview Tables

## TABLE I-1. DISTRIBUTION OF THE FY 1994 BUDGET

**Table I-1.** Distribution of the FY 1994 Budget (Outlays in billions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Discretionary | | | | |
| Defense | 302.6 | 292.1 | 277.7 | -4.9% |
| (R&D Included) | (39.0) | (41.6) | (42.1) | 1.3% |
| International | 19.2 | 21.9 | 21.3 | -2.7% |
| Domestic | 214.2 | 239.7 | 251.1 | 4.8% |
| Total Nondefense | 233.4 | 261.6 | 272.4 | 4.1% |
| (R&D Included) | (28.7) | (30.3) | (31.8) | 4.7% |
| TOTAL Discretionary | 536.0 | 553.7 | 550.1 | -0.7% |
| (R&D Included) | (67.7) | (72.0) | (73.9) | 2.7% |
| Mandatory | | | | |
| Social Security | 285.2 | 302.2 | 318.1 | 5.3% |
| Medicare | 116.2 | 129.8 | 144.4 | 11.2% |
| Deposit Insurance | 2.6 | 2.8 | 7.5 | 167.9% |
| Other Mandatory | 241.5 | 277.6 | 283.1 | 2.0% |
| TOTAL Mandatory | 645.5 | 712.4 | 753.1 | 5.7% |
| Net Interest | 199.4 | 201.5 | 212.1 | 5.3% |
| TOTAL Outlays | 1,380.9 | 1,467.6 | 1,515.3 | 3.3% |
| TOTAL Receipts | 1,090.5 | 1,145.7 | 1,251.3 | 9.2% |
| Estimated Deficit | -290.4 | -321.9 | -264.0 | -18.0% |
| **Constant FY 1987 Dollars** | | | | |
| Discretionary | | | | |
| Defense | 249.7 | 234.9 | 216.6 | -7.8% |
| (R&D Included) | (32.2) | (33.5) | (32.9) | -1.7% |
| International | 15.8 | 17.6 | 16.6 | -5.7% |
| Domestic | 176.7 | 192.8 | 195.9 | 1.6% |
| Total Nondefense | 192.6 | 210.4 | 212.5 | 1.0% |
| (R&D Included) | (23.7) | (24.4) | (24.8) | 1.5% |
| TOTAL Discretionary | 442.3 | 445.3 | 429.1 | -3.6% |
| (R&D Included) | (55.9) | (57.9) | (57.7) | -0.4% |
| Mandatory | | | | |
| Social Security | 235.3 | 243.0 | 248.1 | 2.1% |
| Medicare | 95.9 | 104.4 | 112.6 | 7.9% |
| Deposit Insurance | 2.1 | 2.3 | 5.9 | 159.8% |
| Other Mandatory | 199.3 | 223.3 | 220.8 | -1.1% |
| TOTAL Mandatory | 532.6 | 572.9 | 587.5 | 2.5% |
| Net Interest | 164.5 | 162.1 | 165.5 | 2.1% |
| TOTAL Outlays | 1,139.5 | 1,180.3 | 1,182.1 | 0.1% |
| TOTAL Receipts | 899.8 | 921.4 | 976.1 | 5.9% |
| Estimated Deficit | -239.6 | -258.9 | -205.9 | -20.5% |

Source: Office of Management and Budget.

# TABLE I-2. HISTORICAL TRENDS IN R&D AND FEDERAL OUTLAYS

**Table I-2.** Historical Trends in R&D and Federal Outlays (in billions of dollars)

| | FY 1970 Actual | FY 1980 Actual | FY 1990 Actual | FY 1994 Budget |
|---|---|---|---|---|
| **Composition of Federal Outlays (Current Dollars)** | | | | |
| Mandatory Programs | 56.7 | 261.9 | 566.8 | 753.1 |
| Net Interest | 14.4 | 52.5 | 184.2 | 212.1 |
| Defense Discretionary | 81.9 | 134.6 | 300.1 | 277.7 |
| International Discretionary | 4.0 | 12.8 | 19.1 | 21.3 |
| Domestic Discretionary | 38.7 | 129.1 | 182.5 | 251.1 |
| TOTAL Federal Outlays | 195.7 | 590.9 | 1,252.7 | 1,515.3 |
| Federal R&D Outlays Included: | | | | |
| In Defense Discretionary | 8.3 | 15.0 | 41.6 | 42.1 |
| In International Discretionary | NA | 0.1 | 0.4 | 0.4 |
| In Domestic Discretionary | 7.5 | 16.7 | 23.3 | 31.8 |
| TOTAL R&D Outlays | 15.7 | 31.8 | 65.3 | 73.9 |
| **Composition of Federal Outlays (Percent)** | | | | |
| Mandatory Programs | 29.0% | 44.3% | 45.2% | 49.7% |
| Net Interest | 7.4% | 8.9% | 14.7% | 14.0% |
| Defense Discretionary | 41.8% | 22.8% | 24.0% | 18.3% |
| International Discretionary | 2.0% | 2.2% | 1.5% | 1.4% |
| Domestic Discretionary | 19.8% | 21.8% | 14.6% | 16.6% |
| TOTAL Federal Outlays | 100.0% | 100.0% | 100.0% | 100.0% |
| **Federal R&D Outlays as Percent of Discretionary Outlays 1/** | | | | |
| Defense | 10.1% | 11.1% | 13.9% | 15.2% |
| International | — | 1.0% | 2.0% | 1.8% |
| Civilian | 19.3% | 12.9% | 12.8% | 12.7% |
| Total R&D as percent of Total | 12.6% | 11.5% | 13.0% | 13.4% |
| **Federal R&D Outlays as Percent of GDP** | | | | |
| Defense R&D | 0.8% | 0.6% | 0.8% | 0.6% |
| Nondefense R&D 2/ | 0.8% | 0.6% | 0.4% | 0.5% |
| Total Federal R&D | 1.6% | 1.2% | 1.2% | 1.1% |

Source: Authors' estimates based on Budget of the United States Government, Historical Tables and OMB data on R&D.

1/Figures show R&D as a percent of its respective category (e.g., Defense R&D as a percent of Defense Discretionary outlays).

2/Includes international and civilian R&D programs.

# TABLE I-3. BUDGET AUTHORITY, OBLIGATIONS, AND OUTLAYS

**Table I-3.** Budget Authority, Obligations, and Outlays for R&D (in billions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93-94 |
|---|---|---|---|---|
| Defense R&D | | | | |
| Budget Authority | 41.2 | 42.3 | 42.5 | 0.5% |
| Obligations | 39.6 | 43.1 | 40.7 | -5.6% |
| Outlays | 39.0 | 41.6 | 42.1 | 1.3% |
| Nondefense R&D | | | | |
| Budget Authority | 30.7 | 30.9 | 32.9 | 6.6% |
| Obligations | 30.9 | 32.3 | 33.4 | 3.4% |
| Outlays | 28.7 | 30.3 | 31.8 | 4.7% |
| Total R&D BA | 71.9 | 73.2 | 75.4 | 3.1% |
| Total R&D Obligations | 70.5 | 75.4 | 74.2 | -1.7% |
| Total R&D Outlays | 67.7 | 72.0 | 73.9 | 2.7% |
| **Constant FY 1987 Dollars (Budget Authority Only)** | | | | |
| Defense R&D | 34.0 | 34.0 | 33.2 | -2.5% |
| Nondefense R&D | 25.3 | 24.8 | 25.7 | 3.4% |
| TOTAL R&D | 59.4 | 58.9 | 58.8 | 0.0% |

Source: OMB's data for R&D for FY 1994 and agency budget justifications. Constant dollar conversions based on OMB's GDP deflators.

# TABLE I-4. MAJOR COMPONENTS OF FEDERAL FUNDING

**Table I-4.** Major Components of Federal Funding for R&D 1/ (budget authority in billions of dollars)

| | FY 1980 Actual | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 | % Share of Total | |
|---|---|---|---|---|---|---|---|
| | | | | | | 1980 | 1994 |
| Defense | 15.4 | 41.2 | 42.3 | 42.5 | 0.5% | 46.7% | 56.4% |
| Nondefense 2/ | 17.6 | 30.7 | 30.9 | 32.9 | 6.6% | 53.3% | 43.6% |
| Space | 4.8 | 7.8 | 8.0 | 8.4 | 5.8% | 14.6% | 11.2% |
| Health | 4.2 | 10.4 | 10.7 | 11.0 | 3.2% | 12.7% | 14.6% |
| Energy | 4.2 | 3.4 | 2.9 | 3.1 | 7.0% | 12.7% | 4.1% |
| General Science | 1.4 | 3.4 | 3.4 | 4.0 | 16.8% | 4.2% | 5.3% |
| Natural Resources | 1.0 | 1.8 | 1.8 | 1.9 | 6.6% | 3.0% | 2.5% |
| Agriculture | 0.6 | 1.3 | 1.3 | 1.2 | -3.4% | 1.8% | 1.6% |
| Transportation | 0.9 | 1.4 | 1.5 | 1.8 | 22.0% | 2.7% | 2.4% |
| Commerce | 0.1 | 0.2 | 0.3 | 0.5 | 35.5% | 0.3% | 0.6% |
| All Other | 0.4 | 1.1 | 1.0 | 1.0 | -5.5% | 1.3% | 1.3% |
| TOTAL R&D | 33.0 | 71.9 | 73.2 | 75.4 | 3.1% | 100.0% | 100.0% |
| **Constant FY 1987 Dollars** | | | | | | | |
| Defense | 21.8 | 34.0 | 34.0 | 33.2 | -2.5% | 46.7% | 56.4% |
| Nondefense 2/ | 24.9 | 25.3 | 24.8 | 25.7 | 3.4% | 53.3% | 43.6% |
| Space | 6.8 | 6.4 | 6.4 | 6.6 | 2.6% | 14.6% | 11.2% |
| Health | 6.0 | 8.6 | 8.6 | 8.6 | 0.1% | 12.7% | 14.6% |
| Energy | 6.0 | 2.8 | 2.3 | 2.4 | 3.7% | 12.7% | 4.1% |
| General Science | 2.0 | 2.8 | 2.7 | 3.1 | 13.3% | 4.2% | 5.3% |
| Natural Resources | 1.4 | 1.4 | 1.4 | 1.5 | 3.4% | 3.0% | 2.5% |
| Agriculture | 0.8 | 1.1 | 1.0 | 1.0 | -6.3% | 1.8% | 1.6% |
| Transportation | 1.3 | 1.2 | 1.2 | 1.4 | 18.4% | 2.7% | 2.4% |
| Commerce | 0.1 | 0.2 | 0.3 | 0.4 | 31.4% | 0.3% | 0.6% |
| All Other | 0.6 | 0.9 | 0.8 | 0.8 | -8.4% | 1.3% | 1.3% |
| TOTAL R&D | 46.8 | 59.4 | 58.9 | 58.8 | 0.0% | 100.0% | 100.0% |

Source: Authors' estimates based on data from OMB and agency budget justifications. Constant FY 1987 dollars based on OMB's GDP deflators. Classifications generally follow the government's budget function categories except health (which here includes health R&D in HHS, VA, and Education).

1/ Includes conduct of R&D and R&D facilities.

2/ Includes all R&D not in defense.

# TABLE I-5. R&D BY CHARACTER OF WORK

**Table I-5.** R&D by Character of Work (budget authority in billions of dollars)

| | FY 1980 Actual | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | Share of Total FY 1980 | Share of Total FY 1994 |
|---|---|---|---|---|---|---|
| Basic Research | 4.7 | 12.9 | 13.5 | 13.9 | 14.2% | 18.4% |
| Applied Research | 6.9 | 12.7 | 13.6 | 13.9 | 20.8% | 18.4% |
| Total Research | 11.6 | 25.6 | 27.1 | 27.7 | 35.1% | 36.8% |
| Development | 20.0 | 42.9 | 43.0 | 44.6 | 60.4% | 59.1% |
| Total Conduct of R&D | 31.6 | 68.5 | 70.1 | 72.3 | 95.5% | 95.9% |
| R&D Facilities | 1.5 | 3.4 | 3.1 | 3.1 | 4.5% | 4.1% |
| TOTAL R&D | 33.0 | 71.9 | 73.2 | 75.4 | 100.0% | 100.0% |
| **Constant FY 1987 Dollars** | | | | | | |
| Basic Research | 6.7 | 10.7 | 10.8 | 10.8 | 14.2% | 18.4% |
| Applied Research | 9.8 | 10.5 | 10.9 | 10.8 | 20.8% | 18.4% |
| Total Research | 16.4 | 21.1 | 21.8 | 21.6 | 35.1% | 36.8% |
| Development | 28.3 | 35.4 | 34.6 | 34.8 | 60.4% | 59.1% |
| Total Conduct of R&D | 44.7 | 56.6 | 56.4 | 56.4 | 95.5% | 95.9% |
| R&D Facilities | 2.1 | 2.8 | 2.5 | 2.4 | 4.5% | 4.1% |
| TOTAL R&D | 46.8 | 59.4 | 58.9 | 58.8 | 100.0% | 100.0% |

Source: OMB data for R&D for FY 1994, and *AAAS Report VI* (1981). Constant dollar conversions based on OMB's GDP deflators.

**Table I-6.** Defense and Non-Defense R&D by Character of Work (budget authority in billions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 | FY 1994 Distribution | |
|---|---|---|---|---|---|---|
| | | | | | Category | Total |
| Basic Research | | | | | | |
| Defense | 1.1 | 1.4 | 1.3 | -3.8% | 9.1% | 1.7% |
| Nondefense | 11.8 | 12.1 | 12.6 | 4.3% | 90.9% | 16.7% |
| Total | 12.9 | 13.5 | 13.9 | 2.9% | 100.0% | 18.4% |
| Applied Research | | | | | | |
| Defense | 3.8 | 4.6 | 4.0 | -13.6% | 28.9% | 5.3% |
| Nondefense | 8.8 | 8.9 | 9.9 | 10.3% | 71.1% | 13.1% |
| Total | 12.7 | 13.6 | 13.9 | 2.1% | 100.0% | 18.4% |
| Development | | | | | | |
| Defense | 35.1 | 35.6 | 36.7 | 3.2% | 82.3% | 48.7% |
| Nondefense | 7.8 | 7.4 | 7.9 | 5.9% | 17.7% | 10.5% |
| Total | 42.9 | 43.0 | 44.6 | 3.7% | 100.0% | 59.1% |
| Total Conduct of R&D | | | | | | |
| Defense | 40.1 | 41.6 | 42.0 | 0.9% | 58.0% | 55.7% |
| Nondefense | 28.5 | 28.5 | 30.4 | 6.7% | 42.0% | 40.3% |
| Total | 68.5 | 70.1 | 72.3 | 3.2% | 100.0% | 95.9% |
| R&D Facilities | | | | | | |
| Defense | 1.1 | 0.7 | 0.5 | -24.3% | 17.6% | 0.7% |
| Nondefense | 2.2 | 2.4 | 2.5 | 6.1% | 82.4% | 3.4% |
| Total | 3.4 | 3.1 | 3.1 | -0.9% | 100.0% | 4.1% |
| TOTAL R&D | | | | | | |
| Defense | 41.2 | 42.3 | 42.5 | 0.5% | 56.4% | 56.4% |
| Nondefense | 30.7 | 30.9 | 32.9 | 6.6% | 43.6% | 43.6% |
| TOTAL R&D | 71.9 | 73.2 | 75.4 | 3.1% | 100.0% | 100.0% |

Source: OMB data for R&D for FY 1994, and agency supporting data.

# TABLE I-7. R&D IN SELECTED AGENCIES

**Table I-7.** R&D in Selected Agencies (budget authority in millions of dollars) 1/

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | %Change FY 93-94 Current $ | Constant $ |
|---|---|---|---|---|---|
| Department of Defense | 37,779 | 39,065 | 39,504 | 1.1% | -1.9% |
| Dept. of Energy - Defense | 3,452 | 3,254 | 3,016 | -7.3% | -10.1% |
| Total Defense | (41,231) | (42,319) | (42,520) | 0.5% | -2.5% |
| Dept. of Energy - General Science | 1,441 | 1,398 | 1,578 | 12.8% | 9.4% |
| Dept. of Energy - Energy | 3,240 | 2,738 | 2,935 | 7.2% | 3.9% |
| Total DOE | (8,133) | (7,391) | (7,528) | 1.9% | -1.2% |
| National Aeronautics and Space Administration | 8,544 | 8,847 | 9,546 | 7.9% | 4.7% |
| National Science Foundation | 1,972 | 2,009 | 2,402 | 19.6% | 16.0% |
| National Institutes of Health 2/ | 9,624 | 9,890 | 10,208 | 3.2% | 0.1% |
| Other Health & Human Services | 555 | 595 | 624 | 4.9% | 1.8% |
| Department of Agriculture | 1,519 | 1,469 | 1,439 | -2.0% | -5.0% |
| Environmental Protection Agency | 493 | 511 | 548 | 7.1% | 3.9% |
| Department of Education | 167 | 168 | 178 | 6.0% | 2.8% |
| National Oceanic & Atmospheric Administration | 379 | 395 | 424 | 7.3% | 4.1% |
| National Institute of Standards and Technology | 198 | 331 | 451 | 36.0% | 31.9% |
| U.S. Geological Survey | 366 | 359 | 378 | 5.4% | 2.2% |
| Bureau of Mines | 106 | 110 | 90 | -18.2% | -20.6% |
| All Other | 2,105 | 2,036 | 2,099 | 3.1% | 0.0% |
| Total Nondefense | (30,709) | (30,857) | (32,892) | 6.6% | 3.4% |
| TOTAL R&D | 71,941 | 73,176 | 75,412 | 3.1% | 0.0% |

Source: OMB data for R&D for FY 1994, and agency budget justifications.

1/Includes conduct of R&D and R&D facilities.

2/Reflects transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration under P.L. 102-321.

# TABLE I-8. CONDUCT OF BASIC RESEARCH BY AGENCY

**Table I-8.** Conduct of Basic Research by Agency in Current Dollars (budget authority in millions of dollars)

| | FY 1980 | FY 1992 | FY 1993 | FY 1994 | %Change FY 93-94 | |
|---|---|---|---|---|---|---|
| | Actual | Actual | Est | Budget | Current $ | Constant $ |
| Health and Human Services | 1,762 | 5,476 | 5,691 | 5,777 | 1.5% | -1.5% |
| National Institutes of Health 1/ | (1,644) | (5,473) | (5,685) | (5,774) | 1.6% | -1.5% |
| National Science Foundation | 830 | 1,743 | 1,738 | 2,047 | 17.8% | 14.3% |
| Defense (Military) | 552 | 1,146 | 1,324 | 1,256 | -5.1% | -8.0% |
| Energy | 523 | 1,713 | 1,751 | 1,682 | -3.9% | -6.8% |
| National Aeronautics and Space Administration | 559 | 1,764 | 1,887 | 2,007 | 6.3% | 3.1% |
| Agriculture | 280 | 597 | 596 | 623 | 4.6% | 1.5% |
| Interior | 72 | 230 | 225 | 213 | -5.4% | -8.2% |
| Smithsonian | 41 | 106 | 109 | 109 | -0.5% | -3.5% |
| Commerce | 31 | 35 | 36 | 40 | 11.3% | 8.0% |
| Veterans Affairs | 14 | 16 | 13 | 11 | -13.7% | -16.3% |
| Education | 18 | 5 | 5 | 5 | 5.9% | 2.7% |
| Environmental Protection Agency | 13 | 78 | 74 | 80 | 7.6% | 4.3% |
| Agency for International Development | — | 6 | 7 | 6 | -12.6% | -15.2% |
| Other | 21 | 28 | 29 | 16 | -43.2% | -44.9% |
| TOTAL Basic Research | 4,716 | 12,943 | 13,485 | 13,873 | 2.9% | — |
| TOTAL in Constant FY 1987 Dollars | 6,682 | 10,680 | 10,845 | 10,822 | — | -0.2% |

Source: OMB data for R&D for FY 1994 and agency supporting data

1/Reflects transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration under P.L. 102-321

# TABLE I-9. SUPPORT FOR CONDUCT OF R&D AT COLLEGES

**Table I-9.** Estimated Support for Conduct of R&D at Colleges and Universities in Current Dollars (budget authority in millions)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | %Change FY 93-94 | |
|---|---|---|---|---|---|
| | | | | Current $ | Constant $ |
| Health and Human Services | 6,044 | 5,920 | 6,023 | 1.7% | -1.3% |
| National Institutes of Health 1/ | (5,925) | (5,796) | (5,886) | 1.6% | -1.5% |
| National Science Foundation | 1,361 | 1,380 | 1,641 | 18.9% | 15.3% |
| Defense (Military) | 1,309 | 1,452 | 1,333 | -8.2% | -11.0% |
| Agriculture | 426 | 437 | 440 | 0.7% | -2.3% |
| Energy | 671 | 700 | 624 | -10.8% | -13.5% |
| National Aeronautics and Space Administration | 663 | 726 | 750 | 3.3% | 0.2% |
| Agency for International Development | 42 | 32 | 30 | -5.6% | -8.4% |
| Environmental Protection Agency | 71 | 75 | 80 | 6.3% | 3.1% |
| Education | 103 | 106 | 112 | 5.7% | 2.5% |
| Interior | 56 | 59 | 56 | -6.2% | -9.0% |
| Transportation | 45 | 46 | 46 | 1.1% | -1.9% |
| Commerce | 52 | 54 | 55 | 2.4% | -0.7% |
| Other | 19 | 16 | 16 | -1.3% | -4.2% |
| TOTAL Colleges & Universities | 10,861 | 11,003 | 11,206 | 1.8% | — |
| TOTAL in Constant FY '87 Dollars | 8,962 | 8,849 | 8,741 | — | -1.2% |

Source: OMB data for R&D for FY 1994 and agency supporting data. Constant FY 1987 dollars based on OMB's GDP deflators.

1/Reflects restructuring of National Institutes of Health (NIH) and the transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) under P.L. 102-321.

# TABLE I-10. NATIONAL PATTERN OF R&D

**Table I-10.** National Pattern of R&D: Estimated 1992 Expenditures and 2-Year Constant Dollar Changes 1990–92 (in millions of dollars)

| | Sources of Funds | | | | |
|---|---|---|---|---|---|
| | Federal Gov't | Industry | Colleges & Univ. | Non-profit Institutions | Total Funds for R&D |
| **Estimated Expenditures, 1992** | | | | | |
| Federal | 17,600 | 0 | 0 | 0 | 17,600 |
| Industry | 31,300 | 79,000 | 0 | 0 | 110,300 |
| Colleges and Universities | 10,900 | 1,350 | 5,250 | 1,500 | 19,000 |
| FFRDCs 1/ | 5,100 | 0 | 0 | 0 | 5,100 |
| Nonprofits | 3,300 | 700 | 0 | 1,400 | 5,400 |
| TOTAL Performers | 68,200 | 81,050 | 5,250 | 2,900 | 157,400 |
| **Two Year % Change in Constant 1987 Dollars (1990–1992)** | | | | | |
| Federal | 2.8% | — | — | — | 2.8% |
| Industry | -4.3% | 0.1% | — | — | -1.2% |
| Colleges and Universities | 6.0% | 11.2% | 12.7% | 14.6% | 8.8% |
| FFRDCs 1/ | -1.3% | — | — | — | -1.3% |
| Nonprofits | 6.4% | 9.0% | — | 13.8% | 8.5% |
| TOTAL Performers | -0.3% | 0.3% | 12.7% | 14.2% | 0.7% |

Source: National Science Foundation, *National Patterns of R&D Resources: 1992.* Constant dollar conversions based on OMB's GDP deflators. GDP estimate based on GDP data in the *Budget of the United States Government.* Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report. Capital expenditures for R&D are generally excluded.

1/Federally Funded Research and Development Centers.

# TABLE I-11. NATIONAL FUNDS FOR R&D BY SOURCE OF FUNDS

**Table I-11.** National Funds for R&D by Source of Funds (in millions of dollars)

| | 1970 | 1980 | 1991 | 1992 | Percent Share of Total | | |
|---|---|---|---|---|---|---|---|
| | Actual | Actual | Prelim. | Est. | 1970 | 1980 | 1992 |
| **Current Dollars** | | | | | | | |
| Federal | 14,891 | 29,461 | 65,200 | 68,200 | 57.0% | 47.1% | 43.3% |
| Industry | 10,444 | 30,912 | 78,250 | 81,050 | 40.0% | 49.4% | 51.5% |
| Colleges and Universities | 462 | 1,334 | 4,750 | 5,250 | 1.8% | 2.1% | 3.3% |
| Nonprofits | 337 | 903 | 2,600 | 2,900 | 1.3% | 1.4% | 1.8% |
| TOTAL | 26,134 | 62,610 | 150,800 | 157,400 | 100.0% | 100.0% | 100.0% |
| **Constant 1987 Dollars** | | | | | | | |
| Federal | 43,025 | 41,741 | 55,348 | 56,457 | 57.0% | 47.1% | 43.3% |
| Industry | 30,176 | 43,797 | 66,426 | 67,094 | 40.0% | 49.4% | 51.5% |
| Colleges and Universities | 1,335 | 1,890 | 4,032 | 4,346 | 1.8% | 2.1% | 3.3% |
| Nonprofits | 974 | 1,279 | 2,207 | 2,401 | 1.3% | 1.4% | 1.8% |
| TOTAL | 75,510 | 88,708 | 128,014 | 130,298 | 100.0% | 100.0% | 100.0% |
| % GDP | 2.65% | 2.37% | 2.66% | 2.65% | | | |

Source: National Science Foundation, *National Patterns of R&D Resources: 1992.* Constant dollar conversions based on OMB's GDP deflators. GDP estimate based on GDP data in the *Budget of the United States Government.* Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report. Capital expenditures for R&D are generally excluded.

# TABLE I-12. NATIONAL FUNDS FOR R&D BY PERFORMERS

**Table I-12.** National Funds for R&D by Performers (in millions of dollars)

|  | 1970 Actual | 1980 Actual | 1991 Prelim. | 1992 Est. | Percent Share of Total 1970 | Percent Share of Total 1980 | Percent Share of Total 1992 |
|---|---|---|---|---|---|---|---|
| **Current Dollars** |  |  |  |  |  |  |  |
| Federal | 4,079 | 7,632 | 16,500 | 17,600 | 15.6% | 12.2% | 11.2% |
| Industry | 18,067 | 44,505 | 106,750 | 110,300 | 69.1% | 71.1% | 70.1% |
| Colleges and Universities | 2,335 | 6,077 | 17,450 | 19,000 | 8.9% | 9.7% | 12.1% |
| FFRDCs 1/ | 737 | 2,246 | 5,000 | 5,100 | 2.8% | 3.6% | 3.2% |
| Nonprofits | 916 | 2,150 | 5,100 | 5,400 | 3.5% | 3.4% | 3.4% |
| TOTAL | 26,134 | 62,610 | 150,800 | 157,400 | 100.0% | 100.0% | 100.0% |
| **Constant 1987 Dollars** |  |  |  |  |  |  |  |
| Federal | 11,786 | 10,813 | 14,007 | 14,570 | 15.6% | 12.2% | 11.2% |
| Industry | 52,202 | 63,056 | 90,620 | 91,308 | 69.1% | 71.1% | 70.1% |
| Colleges and Universities | 6,747 | 8,610 | 14,813 | 15,728 | 8.9% | 9.7% | 12.1% |
| FFRDCs 1/ | 2,129 | 3,182 | 4,244 | 4,222 | 2.8% | 3.6% | 3.2% |
| Nonprofits | 2,647 | 3,046 | 4,329 | 4,470 | 3.5% | 3.4% | 3.4% |
| TOTAL | 75,510 | 88,708 | 128,014 | 130,298 | 100.0% | 100.0% | 100.0% |

Source: National Science Foundation, *National Patterns of R&D Resources: 1992*.
Constant dollar conversions based on OMB's GDP deflators. Amounts represent current operating costs based on data from performers of R&D and therefore do not correspond exactly to the figures for R&D elsewhere in this report.
Capital expenditures for R&D are generally excluded.
1/Federally Funded Research and Development Centers.

# TABLE I-13. INDUSTRY SPENDING FOR R&D BY *BUSINESS WEEK*

**Table I-13.** Industry Spending for R&D by *Business Week* Groupings, 1991 (in millions of dollars)

| Industry | 1991 | % Change from 1990 | Percent of Total |
|---|---|---|---|
| Aerospace | 4,111.9 | 6.0% | 5.5% |
| Automotive | 11,477.4 | 7.0% | 15.5% |
| Chemicals | 5,144.0 | 0.0% | 6.9% |
| Conglomerates | 3,550.4 | -3.0% | 4.8% |
| Consumer Products | 2,022.0 | 11.0% | 2.7% |
| Containers and Packaging | 112.3 | 1.0% | 0.2% |
| Electrical and Electronics | 7,374.9 | 6.0% | 9.9% |
| Electrical Products | 728.8 | 5.0% | 1.0% |
| Electronics | 2,705.2 | 7.0% | 3.6% |
| Instruments | 1,283.6 | 1.0% | 1.7% |
| Semiconductors | 2,657.3 | 7.0% | 3.6% |
| Food | 557.9 | 7.0% | 0.8% |
| Fuel | 2,928.3 | 8.0% | 3.9% |
| Health Care | 10,006.7 | 16.0% | 13.5% |
| Drugs and Research | 7,283.1 | 17.0% | 9.8% |
| Medical Products and Services | 2,723.6 | 15.0% | 3.7% |
| Housing | 484.5 | 1.0% | 0.7% |
| Leisure Time Products | 1,957.3 | 10.0% | 2.6% |
| Manufacturing | 3,379.3 | 4.0% | 4.6% |
| Metals and Mining | 428.5 | 8.0% | 0.6% |
| Office Equipment and Computers | 16,188.4 | 6.0% | 21.8% |
| Business Machines and Services | 279.2 | 9.0% | 0.4% |
| Computer Communications | 368.8 | 20.0% | 0.5% |
| Computers | 11,753.1 | 3.0% | 15.8% |
| Data Processing | 186.7 | 8.0% | 0.3% |
| Disk and Tape Drives | 708.7 | 28.0% | 1.0% |
| Peripherals & Other Devices | 1,044.9 | 6.0% | 1.4% |
| Software and Services | 1,547.6 | 18.0% | 2.1% |
| System Design | 299.4 | 11.0% | 0.4% |
| Paper and Forest Products | 536.2 | 5.0% | 0.7% |
| Service Industries | 144.3 | 7.0% | 0.2% |
| Telecommunications | 3,786.8 | 6.0% | 5.1% |
| TOTAL | 74,213.6 | 7.0% | 100.0% |

Source: June 29, 1992, by permission of *Business Week*. (c) 1992.

NOTE: Based on SEC data for companies reporting 1991 sales of $45 million or more, and R&D expenses amounting to at least $1.0 million or at least 1.0 percent of sales.

# Part II

# Agency R&D Budgets

# Introduction

In this section, R&D in the federal budget is examined through the agencies that support and perform the work. Separate chapters examine the R&D activities of the principal R&D agencies. These are followed by budget tables, starting with a summary table of R&D budget totals by agency from FY 1992 to FY 1994, and followed by detailed budget tables for each major agency, to support discussions of the Clinton Administration's programs and policies for R&D.

The discussions of agency R&D programs assess budget trends and policy choices reflected in the FY 1994 budget in as detailed a manner as possible. Some agencies have been treated in greater depth than others, reflecting differences in availability of information or issues of special importance. Aspects of certain important agency R&D budgets which do not appear in this section may be found in the disciplinary chapters in Part III.

Budget figures in the detailed agency tables may not correspond exactly to the amounts in the summary tables here and elsewhere in the report. The data in the summary tables were generally prepared based on OMB and NSF data, while the agency tables were derived using agency budget justifications. R&D is often not managed or budgeted by the agencies in categories that correspond exactly to those used by OMB and NSF for statistical purposes. Where significant differences have been found, they are discussed in footnotes to the agency tables.

Where trends in constant dollars are shown, our calculations are based on the fiscal year deflators developed by OMB.

## AGENCY SUMMARY

The composition by agency of total R&D (conduct and facilities) is shown in Table II-1. The numbers are drawn directly from the budget authority data compiled by OMB for their analyses of the FY1994 budget.

The last column of the table shows the percentage change in constant dollars from FY 1993-94 – "real" dollar figures, intended to reflect trends in the purchasing power of agency R&D allocations. These figures highlight several trends discussed in detail in the sections that follow.

# 5

# R&D in the FY 1994 Department of Defense Budget

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## HIGHLIGHTS

- The defense budget continues to shrink. President Clinton's FY 1994 request for the Department of Defense (DOD) is $250.7 billion in budget authority. Estimated outlays for FY 1994 are $264.2 billion. These numbers compare with President Bush's FY 1993 budget request of $267.6 billion and congressional appropriations of $259.1 billion.
- The proposed DOD research, development, test, and evaluation (RDT&E) budget will show a modest 1.2 percent increase over FY 1993, with $38.6 billion in budget authority (See Table II-2). However, the trend of losing a little to inflation during each of the past several years is apparent in the adjusted numbers. (See Table II-6). With other appropriations included, proposed DOD R&D spending totals $39.5 billion.
- The Clinton Administration's technology base budget request of $4.4 billion for FY 1994 would fall 11.1 percent from FY 1993. (See Tables II-2 and II-4). The drop partly reflects the large number of congressional add-ons last year, and nonetheless represents a small increase over the Bush Administration request of $4.3 billion for FY 1993. For FY 1994, the Basic Research request drops 5.1 percent while Exploratory Development falls 13.2 percent.

- Strategic Programs suffer the largest changes from the previous year, falling $1.6 billion (24.7 percent), principally due to downward adjustments to several large RDT&E programs (Milstar Satellite Communications System, B-2 Advanced Technology Bomber, Space Based Interceptors, and the Limited Defense System).
- For the Strategic Defense Initiative Organization (SDIO), requests in the range of $5 billion are a thing of the past. In fact, on May 14, 1993, just over ten years after Reagan announced the initiative, SDIO officially became the Ballistic Missile Defense Organization (BMDO). In late March, the Aspin Pentagon had requested $3.6 billion for an SDI refocused on theater defense, close to last year's congressional appropriation of $3.7 billion.
- Tactical Programs (up 12.6 percent), Intelligence and Communications Programs (up 8.7 percent), and Defense-wide Mission Support (up 20.3 percent) received a total request of $3 billion above last year (Table II-2). The Clinton Administration's shift away from strategic programs can be seen in these numbers.

## THE DEFENSE BUDGET AND THE DEFENSE ENVIRONMENT

The political environment has changed. In announcing the FY 1994 defense budget, Secretary of Defense Les Aspin noted, "This is in many ways the first truly post-Cold War budget . . . . It cuts Cold War forces and begins to buy the new capabilities we need to meet the new dangers we face." Former Soviet president Mikhail Gorbachev recently addressed a gathering in Thomas Jefferson's Virginia, admiring the founding father's ideas on democracy. The current leader of Russia, Boris Yeltsin, recently considered jointly deploying peacekeeping forces with the United States and the United Nations in the former Communist country of Yugoslavia.

Further evidence of a new world abounds. In the defense budget, there are two new initiatives aimed at establishing military-to-military contacts, especially with states of the former Soviet Union ($50 million), and at assisting with the dismantlement of nuclear weapons ($400 million). Domestically, the defense industry continues to consolidate and redirect some of its resources toward non-defense products and services. Late last year, General Electric agreed to sell its aerospace and military electronics business to Martin Marietta for $3 billion.

General Dynamics put several defense divisions on the market. McDonnell Douglas continues to look for manufacturing partners, while going to court on issues concerning the Navy's canceled stealth fighter and buffeted by questions raised about the C-17 short take-off cargo plane.

Iraq, Iran, and the Middle East have faded from the front pages, to be replaced by Somalia and the former Yugoslavia. For efforts such as that in Somalia, two new defense budget initiatives are included for peacekeeping efforts ($300 million) and humanitarian assistance ($48 million). Presumably, we have moved to an era of lower intensity, lower technology, and relatively localized conflicts.

President Clinton will be presented with the findings from Defense Secretary Aspin's comprehensive FY 1995-99 "Bottom-Up Review of Defense Needs and Programs," due in late summer. Four strategic components shaped the first quick redrawing of this year's budget and will shape the Bottom-Up Review: (1) regional security, (2) weapons of mass destruction, (3) democratic security, and (4) economic security.

The first set of issues include threats from local aggressors on allies and economic interests, ethnic and religious civil wars with the potential for crossing borders, and the breakdown of civil and economic order creating large-scale suffering. The second set of issues arises from the potential for hostile regimes or terrorists gaining control of nuclear weapons and delivery means. The third set centers on the possible return of hostile, authoritarian regimes where struggling democratic administrations are in place. The last set of considerations focuses on the domestic economy and the industrial base needed to maintain necessary levels of scientific and technological skills and capabilities.

In place of the Reagan Administration's plans for a 600-ship Navy, and the Bush Administration's 434 ships, the Clinton Administration plans to deploy 413 battle force ships. Navy carrier groups will fall to 12, Army active divisions will fall to 12, and Air Force tactical fighter wings would decline to 24. Bush's FY 1994 plan called for 14 carrier groups, 14 active divisions, and 27 tactical fighter wings. By FY 1996, the U.S. plans to reduce the number of troops based in Europe to 100,000. Total active military personnel are projected to go to 1.6 million in FY 1994, down from 2.2 million in FY 1987, while reserve forces for the four services are projected to be reduced to 1.0 million from 1.2 million in FY 1987.

Maintaining peak readiness is a priority, and so the operations and maintenance accounts will remain relatively stable. Procurement continues to be cut; the Clinton request of $45.5 billion is less than half of the peak Reagan-era budget, as adjusted for inflation. RDT&E is slowly declining in constant dollars from its peak in the mid-1980s. Basic research has held a steady path in constant dollars over the last decade, hovering between $850 million and $1 billion. Recent statements suggest this course will be maintained.

## RESEARCH PRIORITIES IN THE ARMED SERVICES

The research programs of the three services and defense agencies are becoming more interactive. There have long been informal contacts among the services' basic research groups, but under new policies, the number of formal interactions will increase. Underway is a plan to bring the management of the Navy's basic research, exploratory and advanced development groups (6.1, 6.2, and 6.3A budget categories) to one location, under one director, in Ballston, Virginia. The newly renamed ARPA (Advanced Research Projects Agency, formerly DARPA) is located only a few blocks down the street. Plans are also under consideration to move the Washington, D.C.-based component of the Army and the Air Force's basic research groups to the same Virginia area. And moving to this neighborhood soon will be the National Science Foundation (NSF). This geographical proximity is likely to improve communication among defense and nondefense research funding agencies.

## ARMY RDT&E

RDT&E in the Army received the largest percentage increase among the services from Congress last year (6.6 percent). In the President's FY 1994 request, however, the Army was subjected to the largest percentage decrease (12.7 percent below FY 1993). Exploratory and advanced development would be cut 24.9 percent and 35.6 percent, respectively. Of 29 exploratory development line items in the budget, 24 are planned for reductions in FY 1994. Similarly, of the 26 advanced technology line items in last year's budget, 18 are reduced. Some congressionally initiated programs would be drastically reduced. The controversial AIDS research program is a case in point. Congress appropriated an estimated $53.8 million for it in FY 1993, the Army is requesting only $3.4 million this year.

Another new initiative last year—Small Business Innovation Research (SBIR)/Small Business Technology Transfer Pilot Program, geared toward defense reinvestment and economic growth—started at $67.8 million and is budgeted for close to $63.0 million this year. SBIR programs in the Navy, the Air Force, and the defense agencies all receive funding amounts similar of to last year's.

Another favored budget category—operational systems development—is budgeted for a $2.3 billion increase (a gain of 21.2 percent). This is in line with DOD's emphasis on selectively modernizing key weapons systems such as the Army's M-1 Main Battle Tank, the Bradley Fighting Vehicle, and the Blackhawk helicopter; the Navy's DDG-51 AEGIS-equipped destroyers and F-14 Tomcats; and the Air Force's F-16 Fighting Falcons.

In the Army, operational systems development research, the only research category to show an increase, is up 58.3 percent. These line items cover programs to improve existing fielded equipment and capabilities. Funding for field artillery and combat vehicle improvements, missile improvements, and SATCOM equipment improvements are also slated for increases. The armed services are also budgeting for selected future generation weapons systems in tactical aviation (F-22, F/A-18 E/F versions, and the advanced A/F-X fighter programs), the Army's Comanche light helicopter program, the Navy's Centurion attack submarine, and the MILSTAR and Spacelifter programs.

The Army's key basic research line item—Defense Research Sciences—is maintained at a level just above inflation, $203.7 million (a gain of less than 1 percent). The Army manages basic research through its own labs; through extramural research support to individual investigators; and through R&D agreements among university, industry, and government. A principal focus has recently been on spin-on and spin-off technologies that can benefit both the market economy and the Army.

Several major categories of research can be identified:

- automatic target recognition: the theoretical underpinnings involved with imaging and imaging algorithms.
- fuel cell research: power storage issues involving the soldier-as-a-system with needs for a self-contained environment.
- intelligent turbine systems: efficiency issues.
- digital battlefield: design issues in light enhancement techniques for night vision.
- distributed, interactive simulation: issues in situational training.
- smart materials: surfaces of combat vehicles and aircraft that resist attack, structural materials that are lighter and stronger, materials behavior amidst friction, and materials.
- mobile power: storage issues at the milliwatt, watt, and

megawatt levels for the Army's three main platforms: the soldier, the armored vehicle, and the vertical lift vehicle for propulsion, environmental maintenance, and weaponry.

- manufacturing science: issues involving the production of advanced materials, components, and systems.
- logistic enhancements: issues of resupply across evolving battlefields.
- remote sensors: issues involving threat identification and data fusion from different and complementary systems on the tactical battlefield.

## NAVY RDT&E

Navy RDT&E received a 4.4 percent increase from Congress last fall and is slated for a 3.2 percent increase from the Clinton Administration, rising from $8.9 to $9.2 billion (Table II-3). Reflecting the changes taking place at the DOD level, tactical programs, intelligence and communications programs, and defense-wide mission support all would receive significant increases over last year's appropriations. Operational systems development for tactical programs would receive a major increase, including the addition of $590 million to the F/A-18 fighter squadrons. Two other major funding increases go to line items for the Navy's next generation fighter aircraft and nuclear submarine—the AFX and new design SSN programs, representing additions of $243 and $240 million, respectively. All three additions are offset by the vagaries of RDT&E funding for the controversial, tilt-rotor V-22A Osprey. The Bush administration tried to kill it in 1989, but agreed to fund development of the V-22 program in 1992, as candidate Clinton expressed his support. Congress fought to restore funding to the program, providing an estimated $723.7 million in FY1993; President Clinton has allocated $82.3 million in FY1994.

The two basic research program elements receive increases reflecting the new administration's focus on basic technology. The Navy's Defense Research Sciences (DRS)—the larger of the two 6.1 basic research program elements—increases by 2.0 percent (Table II-5). DRS funding would increase to $416.9 million, incorporating shifts in emphasis among the externally funded, corporate lab, and internal warfare centers' research. The second 6.1 program element, In-House Independent Research, would increase by 1.4 percent.

Meanwhile, fully 12 of the 13 program elements in the 6.2 exploratory development budget were cut. The notable exception is the Small Business Innovative Research/Small Business Technology Transfer Pilot Program.

While the Navy is still very much concerned with deep-sea research, new emphasis has also been placed on a better understanding of littoral warfare—conflicts arising along coastal environments, enclosed and marginal seas. The Navy's experience operating in the Persian Gulf, the Straits of Hormuz, the Gulf of Oman, the Red Sea, the Mediterranean, and now the Adriatic Sea is driving this research. Environmental constraints are vastly different—the operating space is more confined, the reaction times for shore-based threats shorten, friend-or-foe identification needs intensify, threats from low-budget and relatively passive weapons such as mines increase. A second new emphasis for DRS study is environmental quality. The new research thrusts encompass questions in several areas:

- remediation of harbors and shallow, still waters—the problem of dredging and dislodging existing pollutants.
- bioremediation—targeting bacteria at pollutants.
- environmentally sound ships—new research into the clean-up of black water (sewage), grey water (detergents and soaps), and bilge water (oils and solvents).
- oceanographic effects of acoustics on marine animals—the effects of sound emissions (active sonar, communications) on sea life.

All this research will take place under a reorganized Office of Naval Research (ONR). ONR conducts "mission" research that meets criteria of scientific excellence and relevance to the Navy. Yet, Chief of Naval Research, Rear Admiral William Miller, stressed in January that ONR will also strive to develop technologies that have commercial applications in such fields as the physical sciences, engineering, electro-optics, and electronics. "We want to think of dual-use right from the start, to have a positive impact on the economy." Combining basic research, exploratory development, and advanced technology demonstrations under one roof should facilitate this. Four new directorates (Corporate, Science, Technology, and Acquisition) and the 4,000-person Naval Research Lab will be managed by the civilian deputy to the Chief of Naval Research. A major tool will continue to be cooperative research and development agreements (CRADAs), which by the end of 1992 had grown to 80 and were increasing at the rate of 3 to 4 a month.

## AIR FORCE RDT&E

Air Force RDT&E is both the largest among the services, at $13.7 billion, and the recipient of the largest percentage increase over FY1993 (up 4.1 percent). Here again, the category of Operational Systems Development (OSD) is the big gainer, rising $831.6 million (14 percent) to $6.8 billion in FY 1994. The five remaining research categories—Research, Exploratory Development, Advanced Development, Engineering Development, and Management and Support—collectively lose $292.3 million. Budget trends like this highlight one difference in emphasis between the Clinton/Aspin and the Bush/Cheney approaches. Cheney had characterized the 1990s as "a decade of development," rather than production. Cheney's emphasis had been on the successful demonstration of full-scale prototypes, stopping short of production decisions. Aspin, in revamping this so-called "prototyping" strategy, has developed his own four-part resource strategy:

- make selective upgrades to existing systems to extend the useful life, increase capabilities, and maintain parts of the defense industrial base.
- make selective procurements for existing systems at low rates to, again, maintain certain parts of the defense industrial base.
- establish a continuous process of development and prototyping for new defense systems, short of any production decisions.
- make selective procurements of new weapons systems with revolutionary capabilities (high technology "silver bullets").

The major increases to the budget for operational systems development fall under the first of these strategic elements.

Basic Research and Exploratory Development would increase slightly over FY1993 (2.5 percent and 0.5 percent, respectively). For these Technology Base programs, the increase does not keep pace with inflation. The Air Force's Defense Research Sciences gains a modest 2.4 percent (Table II-5). DRS funds mission-relevant basic sciences pursuing, for instance, the following areas:

- mathematical scheduling, multidimensional logistics (*i.e.*, a parts supply stream).
- process issues—reducing the steps necessary in the synthesis of materials.

- lifetime reliability issues in electronic components and systems, understanding substrate cracking in composite materials, bacterial deterioration of electronic materials, and fatigue and corrosion of aircraft structure materials.
- prevention and detection issues in metal matrix and ceramic matrix materials, and use of optical fibers in structures.
- high temperature superconductive devices (SQUIDs)—characterizing eddy currents around micro-cracks.
- non-destructive testing and evaluation, including the use of superconductive materials, x-rays, and ultrasound
- man-machine learning—particularly using machines as intelligent teachers, incorporating reactive learning and mutual adaptation in the education process of Air Force personnel.
- man-machine communication—information processing of visual information (improving standards displays), incorporation of non-standard information sources on threats (aural, tactile), information processing speeds, overload conditions, and data fusion.

While the emphasis in Air Force basic research is necessarily on mission relevance, much of the work is by nature dual-use. The Air Force Office of Scientific Research reported that of 1200 work units (in Air Force labs and universities), approximately 10 percent of the scientific findings were incorporated into Air Force-relevant applications. Of these, nearly a third were incorporated into industry-relevant products.

## RDT&E PRIORITIES IN THE DEFENSE AGENCIES

Several names and acronyms have changed in DOD, reflecting shifts in emphasis and programmatic reorientations. The Strategic Defense Initiative Organization has become the Ballistic Missile Defense Organization, reflecting the de-emphasis of its space-based interceptor program. Immediate choices for development and eventual deployment include several existing programs relying on established military technologies such as radars, rockets, and computerized guidance and control systems. Among these are the Patriot/ERINT (extended range interceptors) systems, the THAAD (theater high altitude area defense) systems, and the Arrow/ACES (Arrow continuation experiments) systems.

ARPA, the Advanced Research Projects Agency (formerly DARPA), has received considerable attention on the basis of its successes in bringing new, innovative, and influential technologies to the armed services. As director Gary Denman said last year, "almost every weapons system that was used [in the Persian Gulf War] could trace its origin to DARPA." But for the past several years, Congress has pressured ARPA, the Pentagon's major source of venture capital for innovative and experimental technologies, to foster more explicitly dual-use technologies for the domestic economy. This February DARPA dropped the D and became ARPA (as it had been two decades ago) by order of President Clinton.

ARPA has long been a recipient of congressional add-ons for programs that the Reagan and Bush Administrations deemed not as important to the defense mission as the budgeted allocations. Measured against the appropriated level of $2.3 billion, Clinton's new ARPA budget of $2.2 billion represents a 3 percent decrease. Compared to Bush's last budget for DARPA ($1.3 billion), however, it reflects a whopping 68.7 percent increase.

Ten programmatic offices will oversee ARPA's expanding portfolio of activities, with the Defense Sciences Office having the responsibilities for identifying and fostering projects in the physical sciences, advanced materials, electromagnetics, advanced batteries, computational mathematics, and biotechnology. R&D will continue on high-definition systems, microelectronics, X-ray lithography, and flat panel displays. In ushering in the new dual-use era of science and technology, the Clinton Administration has designated ARPA as the lead agency for the its Technology Reinvestment Project (TRP), which also includes National Institute of Standards and Technology (NIST), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and Department of Energy (DOE). Total funding will be $472 million. Eleven technology areas will be emphasized: (1) information infrastructure, (2) electronics design and manufacturing, (3) mechanical design and manufacturing, (4) material-structures manufacturing, (5) health care technology, (6) training-instruction technology, (7) environmental technology, (8)aeronautical technologies, (9) vehicle technology, (10) shipbuilding industrial infrastructure, and (11) advanced battery technology.

The Office of the Secretary of Defense (OSD) has an important set of initiatives shaping the DOD science and technology budget. The RDT&E budget for OSD incorporates an 11.9 percent increase to $1.7 billion. Large new program elements in Manufacturing Technology ($147.7 million) and High Performance Computing Modernization

($122.8 million) more than make up for the discontinued Balanced Technology Initiative ($141.7 million). More importantly, OSD is actively shaping the 6.1 budget with several other program elements. Overall, DOD's 6.1 (basic research) budget totals close to $1.3 billion, including $242.6 million for OSD's University Research Initiative and $29.5 for the OSD's new Focused Research Initiatives program. Finally, the Office of the Director of Defense Research and Engineering (DDR&E) has formulated seven research thrusts to focus future DOD research into the 10-to-15-year future, as the environment surrounding the department focuses on dual-use technologies. This year's allocation of close to $30 million is the result.

## 6

# The National Science Foundation FY 1994

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## HIGHLIGHTS

- The 1994 budget begins the Clinton Administration's attempt to greatly increase NSF funding with a request of $3.18 billion, an increase of $450 million over the 1993-enacted budget for NSF.
- Research and Related Activities (R&RA) would increase to $2.2 billion, an increase of $346 million, of which approximately two-thirds would fund fundamental and strategic research performed by individuals and groups.
- NSF plays a key role in FCCSET Initiatives involving R&D in the following areas:

—advanced materials and processing ($321 million)

—biotechnology ($205 million)

—high performance computing and communications ($292 million)

—global change ($149 million)

—advanced manufacturing ($130 million)

- NSF is heavily involved in the FCCSET Mathematics and Science Education Initiative. The Foundation's funding of $622 million continues to make it the largest single-agency supporter of this national initiative, contributing over one-fourth of the federal funding.

## NSF BECOMES PART OF THE CLINTON ADMINISTRATION'S INVESTMENT PLANS

The National Science Foundation faces a rapidly multiplying challenge for FY1994 to satisfy growing expectations by its diverse set of patrons and constituents as government-wide budget constraints tighten still further. For the present year, FY1993, the Foundation has less to spend on research, $1.86 billion, than the prior year, $1.87 billion — the first such lean times in recent memory. Furthermore, even though total funding decreased, congressional appropriators pressured agency officials to increase support for several research initiatives.

The goal of doubling the NSF budget within five years, by 1992, was indicative of NSF's success in selling its importance to its political patrons at the end of the last decade. Unfortunately, the growth in R&D fell far short of doubling — from 1.58 billion in R&D in the 1988 current plan to an expenditure of 2.07 billion for R&D in 1992, a 30 percent increase in current dollars (11.5 percent in constant dollars). If funding for science education is included, the increase in total agency resources was greater, but still shy of doubling, increasing almost exactly 50 percent in current dollars.

In proposing that the NSF budget for FY 1994 grow some16 percent over the 1993 enacted level,[1] the Clinton Administration has become the third consecutive president to endorse a major increase for the Foundation. In his February report, *A Vision for Change for America*, the President proposes that the Foundation budget increase $2.3 billion over the next four years as part of new investments to revitalize U.S. civilian technology development.

## PROMOTING THE NEED TO INVEST IN FUNDAMENTAL RESEARCH

During the past several years, the Foundation has had a significant role in the multi-agency initiatives of FCCSET. These initiatives, beginning with global change and high performance computing and communications, now include science and math education, biotechnology, materials, and manufacturing. NSF involvement in these efforts provided significantly increased resources for the Foundation, and a greater involvement in governmentwide policy deliberations for these endeavors. The gains to the agency appear to have been widespread, in that a share of these efforts fund research that may have been previously categorized under other headings within the budget.

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[1] The NSF budget was proposed in two parts this year. The first installment was part of President Clinton's economic stimulus package, which was technically a supplemental request for the present year, FY 1993. This was followed by additional increases proposed as part of the normal budget submission for FY 1994. A large portion of the stimulus bill (including NSF) was deleted in order to pass the Congress. Unfortunately, this two-stage budget makes detailed analysis of program increases very difficult.

Increasing strategic demands on the agency sparked a healthy discussion on the future direction of the agency. The report, *A Foundation for the 21st Century: A Progressive Framework for the National Science Foundation,"* issued in the Fall of 1993 by the National Science Board Commission on the Future of the National Science Foundation, noted that times have changed and NSF needed to carefully balance its allocation of resources. The Commission stated that NSF "should have two goals in its allocation of its resources...support first-rate research at many points along the frontiers of knowledge... [and] a balanced allocation of resources in strategic research areas in response to scientific opportunities to meet national goals." The Commission further suggested that definitions for the fields of research not become ossified, that the "science and engineering community must better come to grips with the reality that many fields not covered by traditional disciplines offer challenges for new knowledge and opportunities for creative, investigative research..."

Unfortunately, subsequent debate has been enmeshed in a semantic tangle which makes it difficult to sort the issues. Some have used the term "directed research" interchangeably with strategic research to suggest a rigid distinction with "curiosity-driven" or fundamental research. However, such clear distinctions do not appear realistic. A significant portion of **individual** NSF rojects are investigator-initiated fundamental research, performed by individual researchers and small groups, which, **collectively**, are fulfilling a strategic objective.

Indeed, NSF practices appear to remain true to the norms of its academic science constituency. NSF annual figures on the proportion of NSF work that is investigator-initiated have remained relatively stable — about two-thirds of NSF-funded research is in response to investigator-initiated proposals. For FY 1994, the Foundation approximates that some $1.4 billion of the $2.2 billion proposed for the Research and Related portion of the budget will be investigator-initiated research. This will include research categorized as both fundamental and strategic.

A significant share of increases to the NSF budget over the past several years has supported the research areas categorized as strategic, mostly as part of the FCCSET interagency initiatives. Of the $346 million increase proposed for the Research and Related Activities account for FY1994 (over the enacted 1993 level), about two-thirds is targeted for areas identified as FCCSET initiatives. Overall, of the $2.2 billion proposed for R&A funding for FY 1994, over half, or $1.2 billion, is for work in these strategic areas. Arguably, a substantial part of these strategic programs were efforts already underway at the Foundation, but now are differently classified. Science and engineering have been exuberantly dynamic, with new definitions of subdisciplines occurring constantly. Research funded under physics several years ago could easily be funded as part of the materials initiative today. It may be useful to view all research as an investment in the future-in new knowledge and educated human resources. If there are areas that have not increased as fast as others in funding, whether or not they are labeled strategic, perhaps more attention needs to be given to identifying the vitality of the field and how it may contribute in the future.

## ACTIVITY SUMMARIES

### Research and Related Activities

This account, which includes the bulk of NSF's research funding, would increase from the FY1993-enacted level of $1.86 billion to $2.20 billion for FY1994, an increase of $346 million. Of particular interest:

*Biological Sciences — $312 million*

- NSF is the nation's principal supporter of basic cademic research in these areas, providing over 95 percent of funds for research on biodiversity, 75 percent of funds for environmental biology, and 50 percent for plant biology.
- Funds for the Biotechnology FCCSET initiative would increase to $119 million and support research in five focal areas: environmental biotechnology, bioprocessing, bioelectroncis and bionetworks, agricultural biotechnology, and marine biotechnology.
- The environmental research effort would increase to $70 million, which would include funds for the establishment of an Ecological Synthesis and Analysis Center. The Center would promote the study of complex ecological questions and serve as a site for synthesis of large data sets.

- At least $5 million additional funds would be provided to math and science education activities to initiate a new competition for Research Training Groups in strategic initiative areas. These groups provide training for undergraduate, graduate and postdoctoral teams in multidisciplinary research.

- At least an additional $3.75 million would be spent on research instrumentation and $3.0 million to enable greater support for students.

- $12.6 million would be provided to enhance support to the six existing Science and Technology Centers in the biological sciences.

### *Computer and Information Science & Engineering (CISE) — $296 million*

- CISE provides funds for efforts in five strategic initiatives coordinated by FCCSET-high performance computing and communications (for which CISE has the NSF lead), manufacturing, materials, biotechnology, and math and science education.

- The computing and communications initiative would be funded at $254 million and provides support for: new Grand Challenge applications—a coordinated effort in problem-solving environments, research in massively parallel algorithms for intelligent systems, strengthening and broadening access to emerging scalable parallel architectures, research on new high performance architectures and computing systems, extending very high speed networking backbone service and enhancing regional network infrastructure, and increasing human infrastructure support.

- $38.7 million would support advanced manufacturing technologies to increase research on high dependability computer-controlled systems.

- $20.1 million would fund the advanced materials initiative for research on modeling and simulation of electronics and optical materials and devices in optoelectronic computing.

### *Engineering — $323 million*

- Engineering strategy is to promote synergy between engineering education, fundamental research, and the application of technical knowledge. NSF provides about 30 percent of the total federal support for academic engineering research.

- The Advanced Manufacturing initiative would receive $80.4 million for research focussing on next generation manufacturing, computer-integrated tools for rapid prototyping, and manufacturing, and integration into production systems. Part of this increase will fund a new Engineering Research Center for advanced manufacturing and processing (included in the total number of centers cited below)

- $76.2 million would support the materials initiative, emphasizing research to develop novel materials synthesis and processing methods, *e.g.*, the development of new processing techniques critical to the electronics industry.

- $30.2 million to support the biotechnology initiative, focusing on development of new technologies for bioprocessing, bioelectroncis, and bioremediation.

- $30.1 million for the Math and Science initiative. Included are $15.1 million to fund six engineering education coalitions, an increase of up to two more; and $4.1 million for the Research Experiences for Undergraduates program.

- $42 million to support multidisciplinary research to develop new strategies and technologies for the renewal of the nation's decaying civil infrastructure systems, addressing such issues as system behavior and performance, deterioration, assessment, maintenance, repair and construction.

- $52.5 million for the Engineering Research Centers, to increase the number of centers from 18 to 20.

- $33.1 million to meet the Research and Related component of the SBIR program mandated 1.5 percent level of funding.

- Funding would continue for the Industry/University Cooperative Research Center Program to support approximately 12 state centers and 50 regular centers. One million dollars would be provided for a new Industry/University Cooperative Research Projects program.

### *Geosciences —$448.5 million*

- Geosciences supports research in atmospheric, geological and oceanographic science, providing about 70 percent of federal support for academic research in these areas.
- $125 million would augment global change initiative research across all programs, including large international field projects and climate modeling, and joint oceanographic work.
- $3.8 million is proposed for high performance computing and communications work, including Grand Challenge activities in earth sciences and massively parallel processing at the National Center for Atmospheric Research.
- $149 million would fund atmospheric sciences — a third of the funds support large facilities, such as the National Center for Atmospheric Research, over half ($82 million) is for project support; NSF provides about 50 percent of total federal support for basic research in atmospheric sciences.
- $89.7 million would be provided for earth sciences, of which $57 million would be for project support and $25 million would support facilities and instrumentation; NSF is the primary source of federal support for academic basic research in geology, geophysics, geochemistry, and hydrology.
- $209.8 million is proposed for ocean sciences — two-thirds of which support individuals and group research; NSF supports about 70 percent of total federal funds for academic basic research in this area.

### *Mathematical and Physical Sciences — $718.4 million*

- This program supports 38 percent of academic research in astronomical, chemical, materials, mathematical and physical sciences, but is the major source of support in areas such as ground-based astronomy, core mathematics and gravitational physics.

- $281 million is proposed under the FCCSET initiatives across all disciplines: $206.4 million for materials research; $14.7 for high performance computing and communications; $21.5 for biotechnology; $1 million to begin global change work under the mathematics division for modeling; $6.8 million for manufacturing, principally focusing on the processing of chemicals and materials and modeling those processes; and $30.9 million under the mathematics and science initiative for undergraduate research experiences, particularly at minority institutions, and enhancement of postdoctoral fellowship opportunities.

- $72 million would be spent for major research equipment: $43 million for the Laser Interferometer Gravitational Wave Observatory (LIGO), $17 million for the Gemini 8-Meter Telescopes, and $12 million for the High Magnetic Field Laboratory.

- Mathematical sciences would receive $88 million, $70 million of which would provide research project support. NSF provides about 60 percent of federal support for basic research in this field.

- $113.9 million would support the astronomical sciences, of which $40.8 is for research project support and $73.1 is for the National Centers, NSF provides about two-thirds of federal support in this field.

- Chemistry would receive $130.9 million, including $111.5 for research project support and the remainder for instrumentation and infrastructure. NSF provides 40 percent of federal support for academic chemistry.

- Physics would be funded at $142.6 million, with $107 million for research project support. NSF provides about 50 percent of federal support for academic physics.

- $171 million for Materials research would provide $92.4 million for research projects, $56.4 million for research centers and groups and the remainder for national facilities and instrumentation. NSF provides about 50 percent of total federal funds for academic materials research.

### *Social Behavioral and Economic Science — $106.9 million*

- $75.3 million would support social, behavioral and economic research, including about $9 million for activities related to high performance computing and communications, advanced manufacturing, and math and science FCCSET initiatives.
- $18.9 million would support international cooperative scientific activities.
- $12.7 million would fund Science Resources Studies.

## Education and Human Resources

This account would increase from the $488 million enacted for FY 1993 to $556 million for FY 1994, an increase of $68 million. Highlights include:

- $103 million, an increase of about 20 percent, would support Systemic Reform activities. This would provide an additional $14 million, or about 5 new awards, for a total of 8, to the Urban Systemic Initiative. Additional funds would also be provided for technical assistance to aid participants in the Statewide Systemic Initiatives program and sustain approximately 25 ongoing awards.
- EPSCoR (Experimental Program to Stimulate Competitive Research) would be funded at $24.4 million as part of the Systemic Reform activities.
- Elementary, Secondary and Informal Education would receive $198 million for programs to develop instructional materials, teacher enhancement and recognition, informal science education and student enrichment.
- $66 million, an increase of $17 million, would provide for the expansion of targeted efforts to expand the participation of women, minorities and persons with disabilities in science and engineering.
- $75 million would be provided for undergraduate education programs, for curriculum and laboratory development; initiation of efforts in technical education; and increased support for K–12 teacher preparation activities.

- $66 million would support graduate education and faculty development awards.

## U.S. Polar Programs

This program now centralizes NSF efforts on polar programs, relocating responsibility for research activities previously funded under the auspices of the Geoscience program. The total request is for $228 million, of which $26 million would fund Arctic research, $28 million would be for Antarctic research, $108 million would be provided for operations and science support, and $59 million would be for Antarctic logistical support.

## 7

# Health Research (HHS) in the FY 1994 Budget

*Jerold Roschwalb, NASULGC*

## HIGHLIGHTS

- Funding requests for NIH call for a 3.2 percent increase, at least 1 percent short of inflation. The Administration stresses initiatives: AIDS, women's health, breast cancer research, minority health, tuberculosis, high performance computing.
- Minus initiatives, NIH suffers a loss in established programs of about 2.5 percent. Basic research absorbs most of the loss.
- Customary inflation increases for continuing grants are eliminated to find funding for new and competing grants. Nevertheless, the total number of new grants falls again.
- Nine institutes would be funded below FY 1983 levels. Cancer and Infectious Diseases each grow by about 8 percent primarily due to funds for initiatives.
- The success rate for research project grants would be 21.6 percent, the lowest in the past decade.

## PREFACE

Typically, authors of chapters in this text prepare their material from texts provided by OMB and the different federal agencies. The most valuable text is the "justification." Varying among agencies, they usually are meticulously compiled documents prepared for agency leaders who go before the appropriations committees of the Congress to make their case for the President's budget. As this document was prepared to meet the AAAS publication deadline, the NIH "justification" books still were unavailable. This should have some positive consequence: the text having weaker reeds to rely on will be more brief. It is conceivable that the author's tone will be less authoritative. Also, since the story this year is painful, a curtailment of grief may be a gift.

The justification text is bound to be available soon and readers of this chapter who desire further explication of the available information are welcome to pursue the writer of this chapter who will endeavor to find answers to questions.

Note: As always, the available documents are assembled in different quarters. Numbers sometime differ among them because of what may be included (*e.g.*, all of NIH versus R&D only in NIH). The charts located in this book are prepared with meticulous care by the AAAS staff and may be relied upon for the definitive numbers for any purpose.

## RECENT HISTORY

For many years, NIH funding followed a similar pattern: the Administration would propose relatively small increases. Congress would respond with substantially more funding than the Administration asked. There would be real, sometimes substantial, growth over inflation in most of the agency's mechanisms. More recently, the Administration began to request what were considered more reasonable increases, levels that Congress could take seriously, which it did. The major increases of the seventies and eighties changed to increases that supported the enterprise, but no longer allowed major growth.

Last year was an anomaly and a possibly worrisome precursor for medical research. The Administration, again, came in with what would seem to be a reasonable number, approximately $500 million or a roughly 5 percent increase. Congress responded for the first time in the agency's modern history by providing funding lower than the Administration's request, an increase of 2.9 percent. These $291.2 million allowed for increases in every institute or program with the exception of Research Resources, which was cut by 0.6 percent. (The Administration's request would have cut it by 1.7 percent.) With inflation for medical research approaching 5 percent, according to the government's index (BRDPI), this meant that NIH, in constant dollars, had lost ground, and was about $200 million short of simply holding the line.

(It is important to keep in mind that last year the three research institutes of ADAMHA—mental health (NIMH), drug abuse (NIDA), and alcoholism (NIAAA)—were merged into NIH as three independent institutes. Figures now used include their funding levels as part of the total NIH. References to earlier times need to take those numbers into account. For example, of the 5594 new grants in the FY 1994 proposal, 651 are in the three former ADAMHA institutes. This leaves the "old" NIH with 4943 new grants.)

It is necessary to note that what occurred to NIH was part of a much larger congeries of actions and decisions in the Congress. (See AAAS publication, *Congressional Action on Research and Development in the FY 1993 Budget*.) In the 1990 Budget Act, Congress had boxed itself in by freezing the amount of funding it would allow for domestic programs of all sorts. When it had finished its appropriations process for the year, it had funded non-defense research lower than the previous year. This was consistent with available funds rather than a policy plan being implemented. Further, the idea of technology transfer, the capacity for research to help extend America's industrial competitiveness, had taken hold, and those agencies likely to respond to the new thrust (*e.g.*, NIST) were given larger increases. Such allocations obviated the possibility of better funding for the more traditional basic research-oriented agencies.

During the past decade, when earmarking budgets in the Congress, usually for construction projects on campuses, was a growing enterprise, NIH was cited as "earmark-free." But a new form of earmarking became evident in the 1993 appropriation. It involved Congress identifying and mandating the area and type of research the agency was to undertake, limiting the NIH leadership's ability to allocate funds according to scientific priority. More on this below. A combination of esteem for its accomplishments and a sense, even on Capitol Hill, of the ubiquity of mortality had seemed to protect NIH funding levels even during periods of challenge involving alleged and real scientific misconduct and concern over ill-defined conflicts of interest. But NIH went into the FY1994 appropriations process aware of language in the previous year's appropriations report that seemed to chastise it for having spent billions of dollars over two decades without making satisfactory progress against cancer.

## BUDGET PRIORITIES

The total request for NIH for FY 1994 is $10.683 billion, an increase of $329 million or a 3.2 percent increase. Of particular interest are the "earmarks" noted above. Most would agree that, in absolute terms, each of these identified areas for special funding is of high interest and concern and worthy of support. Nevertheless, two problems are cited, particularly by the scientific community. First, by sequestering funds for these "earmarks," the Administration diminishes funds available to the medical research leadership to determine the most effective distribution among mechanisms, disciplines, and areas of opportunity. Second, from the perspective of basic research, these "earmarks" are sharply focused and more "applied" in the nature of their research, thereby diminishing substantially funds available for basic medical research on which the entire enterprise depends. In a period when attention to these "earmark" activities would witness concomitant additional funds appropriated, there would be certainly less concern. However, under current fiscal constraints, in which NIH may operate with less real dollars next year, the increased number and amount of funds dedicated to "earmarks" are seen by some as a threat.

1. AIDS research. There is an increase of 21 percent over FY1993, an increase of $227 million for a total of $1.3 billion. The increases reported in the number of AIDS cases and mortality motivate special attention to this research area. Funding is aimed at increasing knowledge about the nature of the AIDS virus and ways to prevent and treat the infection.

2. Women's health. $61 million are dedicated to this initiative, $20 million over FY 1993. This is part of a fifteen-year project, estimated to cost over $650 million, dealing with many research advances necessary to enhance women's health.

3. Breast cancer research is related to but also separate from the women's health initiative. This program would receive $216 million next year. The funds became available when Sen. Tom Harkin (D-IA) sought to "breech the walls" created by the 1990 budget act that precluded moving funds from defense to nondefense programs. He did succeed in having the $216 million set aside in DOD itself for breast cancer research, funds now reportedly scheduled to be transferred to NIH. With those dollars, NIH would spend $421 million for breast cancer research in FY1994, compared to $87 million in 1990 and $205 million in 1993. It is estimated that the funds will support 131 research project grants, and in addition, research centers, contracts, and training awards.

4. Minority health. An increase of $15 million for a total of $56 million will be devoted to the minority health initiative. This will support a wide array of activities including research in infant

mortality, the health behavior of adolescents and young adults, and biomedical training for members of minorities.

5. Tuberculosis. $46 million will be dedicated to tuberculosis research, an increase of $10 million. Quiescent for many years, TB, and in new strains, has become resurgent particularly among low-income populations. The initiative will focus on new drugs and drug deliveries, clinical trials, new vaccines, and training health care workers.

6. High performance computing and networking. The National Library of Medicine will be the locus for the additional $24 million for advanced computer and networking technology applications. The focus will be applications for health care, an array of technologies that will tie in diagnostic tools such as PET and CAT scans, the transmission of patients' records, and immediate consultation among health care providers.

7. Some would assert additional "earmarks" including:
a) vaccines, + $32.9 million
b) child health, + $4.1 million
c) advanced materials, + $7 million (with FCCSET)

## FUNDING MECHANISMS

### Research Grants

In FY 1992, NIH awarded 6,795 competing grants with a success rate of 29.7 percent. Its high level of awards replicated similar levels in the 1980s. Partly at the direction of congressional appropriations committees, NIH has tightened up the problem of "mortgaging the present." The current number of competing awards, 5,594, reflects the impact of obligations into the future, since the average length of a grant is four years. Slippage in appropriations levels results in having to meet commitments to continuing grants and consequential shortfalls in funding for new grants.

The decline took place last year with 5,652 new grants, a drop of 1,143 from FY 1992. This year's drop is only 58. However, the drop is more severe since a considerable number of new grants have been created by depriving all continuing grants of their 4 percent inflation increase. Also, it is anticipated that there will be very strict funding level determinations for new grants even if the outmoded "downward negotiations" are not applied across-the-board or in some other formula fashion. Total numbers of grants for the three years (1992-1994) are 24,060/23,583/23,196. The totals are less significant than the potential trend. Noteworthy, too, is that the average cost per grant has risen from $228,000 in FY1992 to $240,00 in 1993 to $245,000 in FY1994—another important impact on the numbers of grants that can be funded.

### Research Centers

They appear to be holding their own, rising in number (822/829/838) over the past three years. Funding has risen proportionately ($897 million/$912 million/$950 million) with a 4.1 percent dollar increase this year.

### Other Research

In the category of other research, including many of the special career programs and minority-oriented programs, last year saw a drop of 1.9 percent ($536 million/$525 million) with the biomedical research support program suffering a 23 percent cut ($23 million/$18 million). The BRSG program is virtually eliminated after a decade-long battle for survival. It once was funded at about $60 million. This year, the clinical education program receives a 24.3 percent increase. Cooperative clinical research rises by 10.9 percent. Minority biomedical research support holds steady with 98 programs, though dropping 0.9 percent in funding.

### Training

Individual awards rise by 1.7 percent to 2,264 and institutional awards rise by 1.6 percent to a total of 12,073 awards. From a drop of 284 trainees last year, the new total of 14,337 is an increase of 312.

## OTHER UNITS

### National Library of Medicine

The National Library of Medicine, which houses all of the new computerized applications, shows an increase of 18 percent to a total of 133 million. It received a 10 percent increase last year.

### Office of Director

The office of the director, in which many of the new major initiatives are housed, had an increase of 32 percent last year and receives a 23.4 percent increase this year to a total of $235 million.

## Genome

The Human Genome project is increased 26.8 percent to a total of $135 million. It is on a small base and therefore not very costly, but given the pressures on the budget, may have difficulty maintaining this level on Capitol Hill.

## NIH in Context

- During FY1984-1988, NIH saw an increase of 49 percent (NSF grew by 30 percent and NASA by 23 percent in that same period). During the past five years (FY 1989-1993), NIH grew by 31 percent while NSF grew by 45 percent and NASA 34 percent. Even the domestic discretionary programs that had only grown by 16 percent in the first five-year period grew by 33 percent in the second. NIH lagged behind all. The reason may be coincidence. It may be that the size of NIH—1 percent exceeds $100 million—in a time of constricted budgets limits funding. It could be that a series of negative publicity events surrounding allegations of scientific misconduct lessened the support for NIH in the Congress. It could also be that the medical research community is not informing the country and the Congress of the strides it has made in vaccines, medications, surgical techniques, and the like that have had extraordinary impact on the nation.
- The average cost of a non-competing grant in FY1983 was $124,600. The average cost anticipated in FY1994 will be $244,140. For competing grants, the average costs have risen from $119,000 to $243,000 in FY1994. Except for a couple of years of intense inflation impact, increases have been between 4 and 6 percent. These numbers may be of concern to those responsible for keeping total expenditures down.
- Without questioning the high import of funding for AIDS and breast cancer research and even including the Genome project, the result shows that the rest of NIH has fared negatively. (The nine institutes receiving fewer

funds in current FY 1994 dollars reflect that.) As a "mission agency," NIH is expected to perform research that will yield solutions to medical problems. The initiatives described above (and they comprise virtually the entire section on NIH in the official HHS budget presentation) might be termed "applied," as opposed to "curiosity-driven" research generally referred to as "basic."

The elasticity of budget numbers permits manipulation that arrives at conclusions intended by the manipulator, so it is difficult to speak with certainty over what impact this budget will have on basic research. It is quite clear, however, that basic research takes a meaningful cut in the President's proposed budget.

- Basic research is having a tumultuous time in the proposed budget. Only NSF (plus 18.2 percent) is doing very well. NASA (plus 6.3 percent) is on a positive track, as is USDA (plus 4.7 percent). NIH would have a 1.6 percent increase in basic research. DOD would be minus 1.2 percent, DOD minus 5.6 percent and others minus 3.7 percent. Numbers are especially significant if contrasted with years back when NIH was a leader in basic research.

- Of particular interest is the impact of federal agencies, R&D on colleges and universities. Numbers somewhat reflect the above. NSF leads with plus 18.9 percent. NASA follows (plus 3.3 percent). All of HHS is plus 1.7 percent, while DOD falls (minus 8.2 percent) as does DOE (minus 10.8 percent).

- Readers will recall that the Administration's February budget plan projected saving $1.238 billion on indirect costs. Subsequently, however, the Administration was persuaded that this would be ineffective (since project costs would simply be shifted to direct costs rather than be saved). So to achieve real savings, the cuts had to come out of the request figures themselves. As a result, NIH's proposed budget was reportedly reduced by $223 million. This was considerably more than the estimated $100 million reduction to NIH that would have taken place under the original plan for indirect-cost savings.

- NIAID is listed as having a 8 percent increase. If you remove the AIDS dollars, the institute has a minus 8 percent. Just looking at totals is insufficient. AIDS funds are highly earmarked in some institutes and, therefore, not usable for broader science research. Earmarking science has gone up by a factor of 8 in the past few years. Scientists are expected to identify what disease they are working on no matter their science research interests.

Questions: Would NIH get all of these dollars for basic research if they were not earmarked? Would NIH get **some** of them?

# 8

# R&D in the Department of Energy

*John Hamilton, Sean Tipton, NASULGC*

## HIGHLIGHTS

- The Department of Energy proposes to spend $7,528.4 million on Research Development in FY 1994, an increase of 1.8 percent from 1993 levels.
- The Office of Energy Research (OER) is slated to go to a $3,364 million funding level.
- Funding for the Superconducting Super Collider (SSC) continues, but has been stretched out an additional three years. $627.6 million is proposed for FY 1994.
- The budget proposal focuses U.S. participation in the engineering design of the Thermonuclear Experimental Reactor, the Tokamak Fusion Test Reactor, and the design of the Tokamak Physics Experiment.
- Reflecting changes in global conditions and a new Administration, the emphasis at the Department of Energy is shifting. There is less attention to coal and nuclear, less weapons research, and an increased emphasis on solar and renewable energy, natural gas, more technology transfer, and environmental programs.
- The DOE is heavily involved in the initiatives of the Federal Coordinating Council on Science, Engineering

and Technology (FCCSET) $1.9 billion in FY 1994 is slated for FCCSET programs.

## INTRODUCTION

The overall FY 1994 budget request for the Department of Energy (DOE) is $19.6 billion. This would be an increase of 3.2 percent, or $0.6 billion over the 1993 appropriation.

"We changed our priorities" reads the message spelled out on DOE's FY1994 budget handouts. Evidence of the new Administration's changing priorities for the DOE is apparent in funding realignments which would take from defense-related responsibilities to center on improving energy independence, environmental cleanup, and investments in high priority research initiatives. A noticeable funding decrease for nuclear reactor research stands in contrast to sizeable increases for conservation and renewable R&D programs.

Keeping in line with the new Administration's emphasis on investing in the future, and the goals put forth in the Energy Policy Act of 1992 (EPACT), the FY 1994 DOE budget would strengthen the foundations of basic scientific research at DOE laboratories and universities by increasing support for small science.

Overall DOE's science and technology programs would receive an 8.1 percent increase. Included in that increase is more funding for DOE's national labs for technology transfer activities through cooperative agreements with industry. The new Administration is making it clear that the role of the national labs in the post-Cold War era will be redefined, with the labs playing key roles in basic research and cooperation with industry and universities.

The DOE continues to be a major player in the Federal Coordinating Council for Science, Engineering and Technology (FCCSET), which has been addressing science and technology issues affecting multiple federal agencies since 1976. DOE's FY 1994 FCCSET funding would be $825 million above the FY1993 level. The DOE is once again active in each of the six FCCSET initiatives: advanced materials, advanced manufacturing, biotechnology, high performance computing, math and science education, and the national research program for global change.

## ENERGY SUPPLY RESEARCH AND DEVELOPMENT

The Department has proposed an overall decline in the Energy Supply Research and Development Budget of 3.0 percent for FY1994 to $1.9 billion. In a marked change, the amount proposed for the

Solar and Renewable Energy Program increases nearly 36 percent while the Nuclear program drops 46 percent.

### Solar and Other Renewable

The total Solar and Renewable Energy Research and Development budget increases to $240.2 million dollars, a proposed increase of 35.8 percent.

Solar Technology Transfer goes from $1.9 million to $16.4 million for a unprecedented 743 percent increase. Nearly all the programs would increase under the Administration's proposal; Solar Building Energy Systems increases 72 percent to $5 million, and International Solar Energy Programs nearly double to $5.8 million. Photovoltaic Energy Systems, Solar Thermal Energy Systems, Biofuels and Wind programs are all proposed for increases of between 20 and 30 percent.

### Nuclear Energy R&D

For the second straight year, the Nuclear Energy Research Budget is down sharply. The proposal for the FY 1994 budget is a 53 percent reduction for a $117.2 million total.

Every component of the Nuclear Energy Research program is down; the Space Reactor Power System is down 83.3 percent to $5 million; Advanced Reactor R&D declines 75 percent from $60 to $15 million; the Advanced Radio Isotope Power falls 11.7 percent to $48.1 million; and the Light Water reactors gets a relatively small reduction of 1.6 percent for a $57.8 million total.

### Biological and Environmental Research

The Biological and Environmental Research programs are proposed to receive a small (0.5 percent) increase to $338.1 million. The BER programs develop the knowledge needed to identify, understand and anticipate the long-term health and environmental consequences of energy use and development. Health Effects, General Life Sciences, Medical Applications, Environmental Research and Carbon Dioxide Research are all slated for increases. DOE's contribution to the FCCSET Global Change program is an important component of this program.

### Fusion Energy

The total request for Fusion programs is up 5 percent to $338.4 million.

The main program areas for fusion research this year include: U.S. involvement in the International Thermonuclear Experimental Reactor (ITER), which is included here and moves from the conceptual to the design stage; deuterium-tritium operations at the Tokamak Fusion Test Reactor; and inertial fusion energy research.

### Basic Energy Sciences

The largest component of the Office of Energy Research (OER), the request for BES programs is down this 5.4 percent to $792.6 million. Most of this decrease reflects a decline in construction funds, though some construction, such as the 6-7 GeV Synchrotron Radiation Source at Argonne National Laboratory, continues. Among the programmatic areas, Materials Science increases 2.1 percent to $277 million, Chemical Sciences are up 4.1 percent to $169 million, and Advanced Energy Projects increase a little (4.7 percent) to $11.4 million. Many of these programs are also part of FCCSET initiatives, as are the applied mathematics and high performance computing programs.

## FOSSIL ENERGY RESEARCH AND DEVELOPMENT

The Fossil Energy Research and Development program, aimed at more effective and efficient use of fossil fuels, is slated for an overall decrease of 3.0 percent to $322.2 million. The new Administration has reshaped priorities within this program rather dramatically, moving strongly towards natural gas programs. Coal programs, largely attempts to make coal a more environmentally sensitive fuel, are cut 25 percent, but their $141.3 million total is still the highest of the fossil programs. Petroleum programs increase 29.6 percent to $80.9 million, and gas programs jump 25.3 percent to $101.0 million, 14.0 million of which is for utility gas turbine research.

## ENERGY CONSERVATION

Total energy conservation research spending is up 30.8 percent to $367.8 million.

This includes R&D for end - use technologies in support of the Energy Policy Act. Building Technologies are slated to go up 53.3 percent to $64.5 million, Industrial Technologies increase 19.5 percent to $122.4 million, Transportation Technologies jump 32.1 percent to $174.1 million, and Utility Technologies are up 37.1 percent to $6.8 million.

## GENERAL SCIENCE AND RESEARCH

Another large component of the OER budget, the General Science and Research programs, have a proposed increase of 12.8 percent for a total of $1.57 billion. Funding for the Superconducting Super Collider construction has been stretched out for a $218 million savings; however, the proposal for FY 1994 spending increases to $627.6 million. The Nuclear Physics program is down 11.6 percent to $322.3 million, while the High Energy Physics program increases 5.5 percent to $627.8 million.

## ATOMIC ENERGY DEFENSE ACTIVITIES

DOE's Weapons Activities program supports national security nuclear deterrence by advancing research, development, design testing, and surveillance of nuclear weapons.

The end of the Cold War and change in Administration result in a proposal to reduce spending in this area 7.3 percent to $3.1 billion. Naval Reactors development spending is cut 4.7 percent to $679.4 million, Weapons R&D testing and development falls 8.7 percent to $1,784.5 million, while spending for verification and control technology sees a 26.3% increase to $144.4 million.

Decreasing slightly is the Environmental Restoration program down 0.2 percent to $261.4 million. The University Science and Education program is also under the AEDA umbrella. Spending for these efforts is up 10.7 percent to $58.0 million.

## 9

# NASA in the FY 1994 Budget

*Joanne Padron, AIAA*

## HIGHLIGHTS

- The proposed FY 1994 budget for NASA is $15.265 billion, an increase of $592.4 million or 6.5 percent over the current fiscal year. Research and Development was increased 8.8 percent for a total request of $7.712 billion in FY 1994. This represents half of NASA's total budget request.
- The Space Station program is currently going through a major redesign exercise to reduce program costs. In addition, the program includes a line item entitled, "New Technology Investments," an initiative that is supposed to reflect the President's effort to reinvigorate America's technological competitiveness. The total budget request for these two items is $2.3 billion, an increase of $177 million from FY 1993.
- Aeronautics has been given renewed life and emphasis with a proposed increase of 27 percent for a total of $1.1 billion. Of that portion, 80 million is in transatmospheric research and technology. The remaining portion is set aside for Aeronautics Research and Technology.
- The new Administration has continued support for the Advanced Solid Rocket Motor (ASRM) program which had been canceled under the previous Administration

and was reinstated by Congress. The budget request for FY 1994 is for $280.4 million.

- The Space Science and Applications budget has been broken up into three separate budgetary requests to reflect organizational changes within NASA. These are: Space Science, Life and Microgravity Sciences and Applications, and Mission to Planet Earth.
- The Space Exploration Initiative (SEI) and the New Launch System (NLS) have been terminated.

## INTRODUCTION

The past year has been a rather tumultuous one for NASA. Admiral Richard Truly was asked to "retire" amid flying speculation that the Bush Administration was not pleased with his performance. In came Daniel Goldin, with a background in military space and a record for managing programs on schedule and below budget. During his first year as the new Administrator, Dan Goldin has initiated a few significant organizational changes. Some of the changes include the following:

The Office of Commercial Programs and the Space Research and Technology Program were combined to create a new Office of Advanced Concepts and Technology. In addition, the Office of Space Science and Applications was reorganized into three separate offices. Some staff changes were included in the reorganization of NASA, and has created tension between various people in the aerospace community and the new Administrator. There are those who see the changes as disastrous and those who see the changes as a positive step towards creating a new NASA culture.

## PROPOSED FY 1994 NASA BUDGET

The proposed NASA budget for FY 1994 is $15.265 billion, an increase of $935 million or 6.5 percent above the FY 1993 current estimate of $14.330 billion. In his official statement releasing the budget, NASA Administrator Goldin said, "This budget represents a fiscal declaration of independence from old ways of doing business at NASA. It represents independence from old technologies, old ideas, and old assumptions."

Included in the FY 1994 budget request is a long-term plan to cut projected costs through fiscal year 1998. NASA plans to cut $23.8 billion through FY 1998 with $8.1 billion to be added back, for a total projected savings of $15.7 billion. Included in the projected cost savings through FY 1998 are: $8 billion from the Space Station program; $3.4 billion from the Space Shuttle program; $3.0 billion from National Launch System termination; $1.5 billion from termination of the Tracking Data and Relay Satellite II; and $2.6 billion total from restructuring Cassini, Advanced X-ray Astrophysics Facility, and Earth Observing System programs. Included in the add-backs are: $40 million for the Gravity Probe-B program; $155 million for Aeronautics Research and Technology Program; and $212 million for Aeronautical Research Facilities. The rest of this chapter will restrict itself to NASA's Research and Development budget.

## NASA'S RESEARCH AND DEVELOPMENT PROGRAM

NASA's program of research and development is concerned with "extending our knowledge of the Earth, its space environment, and the universe; expanding the technology for practical applications of space technology; to develop and improve manned and unmanned space vehicles; and to assure continued development of the long-term aeronautics and space research and technology necessary to accomplish national goals."

NASA's research and development program is broken into the following elements:

### Space Station

Once again the Space Station has remained top on the list of controversial programs. Since the program was initiated in 1984, it has undergone numerous design, schedule and budget changes. This year proves to be no exception. The President ordered NASA to reexamine Space Station Freedom due to the fact that it is, "unaffordable in light of total constraints on NASA's budget." NASA's marching orders are to redesign the station "to greatly reduce program costs while still providing significant research capabilities" within three months and provide an assessment by early June of 1993.

The station redesign team is currently reviewing three options that would cost $5 billion, $7 billion and $9 billion. The budget request for FY1994 is $2.3 billion, and until the redesign is complete, it is uncertain how much of this amount will actually go to the program.

Adding more uncertainty to the $2.3 billion request is a new line item tacked unto the Space Station program entitled, New Technology Investments. This program reflects NASA's proposed contribution to the President's new technology initiative released in late

February. The proposed investment package is supposed to push development of cutting-edge technology that can be transferred to the commercial sector. Elements of the package include: Technology Research Institutes, automation and robotics, aeronautics, small Earth probes, and advanced launch technology, among others.

Funding for these and other elements are supposed to come from savings created from the redesigned space station. The idea is that any savings over the next five years from the redesign exercise will go towards funding New Technology Investments. Until NASA unveils its redesign, the Administration will not release a detailed budget request for these two programs—if the two survive.

Current readings within the aerospace community have been negative. The station's international partners are not pleased by the whole exercise and fear for their own portions of the program that they have invested in. Congressional opponents to the station have used the redesign effort to recruit more members to their side. The White House is not satisfied with the initial direction NASA's proposed New Technology Investments has taken. With all these political ramifications, the entire aerospace community is waiting breathlessly for the June release date of a new space station and technology investment package.

## Space Transportation Capability Development

This area received a zero percent change in the budget request for FY 1994 and remains at the $649.2 million current estimate. This does not mean that each line item within space transportation has remained at the current estimate. The joint DOD/NASA New Launch System, better known as NLS, was terminated in this year's budget request. NASA's attempt to justify the need for an improved national launch capability met with resistance in Congress, which gave NASA a mere $10 million in FY 1993 for a portion of the program.

The largest requested increase was in Advanced Programs which grew $27.8 million for a total budget request of $60.7 million. Advanced Programs has four focus areas: 1) advanced transportation; 2) advanced cooperation; 3) advanced space systems; and 4) solid propulsion integrity program.

The largest requested decrease was in Payload Operations and Support Equipment, which dropped 27 percent for a total budget estimate of $95.4 million. Much of the proposed decrease is due to the space station redesign effort.

## Space Science and Applications

Funding requested in this area was increased $191.8 million to $3.057 billion. The original Space Science and Applications program was previously divided into seven subcategories and managed by one program office. These subcategories included: Physics and Astronomy, Life Sciences, Planetary Exploration, Earth Science, Materials Processing in Space, Communications, Information Systems, and Research and Operations Support.

Beginning in FY 1994, the Space Science and Applications has been reorganized into three separate program offices, with three separate budgets – The Office of Space Science, the Office of Life and Microgravity Sciences and Applications, and the Office of Mission to Planet Earth.

*Space Science* now includes the Physics and Astronomy program, Planetary Exploration program, and a portion of Information Systems. The Administration's request for the restructured Space Science Programs is $1.632 billion.

Physics and Astronomy : The budget request for this discipline was increased $32.8 million to $1.063 billion (3.2 percent). Almost 40 percent ($416.2 million) of the request goes to Mission Operations and Data Analysis. Of this request, $222 million will go to the first planned servicing mission of the Hubble Space Telescope scheduled for December 1994 to place an optical correction instrument on the spacecraft.

Also included in this request is $260.3 million for the Advanced X-ray Astrophysics Facility (AXAF) program. This program was restructured during FY 1993 to withstand Congressional action that reduced funding by $7.5 million. The new AXAF program now includes two separate spacecraft: AXAF-I, scheduled for launch in FY 1998, and AXAF-S, scheduled for launch in FY 1999.

Physics and Astronomy also includes $40 million for the Gravity Probe-B program which was initiated in FY 1993 in accordance with congressional direction. Gravity Probe-B will investigate and test Einstein's theory of relativity.

Planetary Exploration would increase 17.7 percent for a total budget request of $557.2 million. Included in this request is $3.5 million for the Mars '94 program, a joint US/Russia mission scheduled for launch in November 1994 aboard a Russian Proton. The US contribution to Mars '94 will be two soil oxidation instruments. Funding for the Cassini mission would increase 30 percent for a total request of $266.6 million. An extensive restructuring exercise was initiated in 1992 over budgetary and technical concerns. Program costs, and mass and power requirements have been reduced significantly for a savings of $300 million. The launch date remains scheduled for October 1997.

*Life and Microgravity Sciences and Application* now combines the Life Sciences and Material Processing in Space portions of the budget. The total request for the restructured program in FY 1994 is $351 million.

Life Sciences would increase from $140.5 million in FY 1993 to $143.9 million in FY 1994. Almost two-thirds ($94.7 million) of this amount will go towards the Flight Experiments program, the objective of which is to expand our understanding of the physiological effects of exposure to the space environment. Funding for the Space Station Centrifuge Facility is not included in this fiscal year request due to the station redesign effort.

Microgravity Science Research would decrease 48 percent to $89.4 million. The majority of this decrease in requested funds is in the Flight Experiments program which would drop $83.5 million for a total request of $71 million. This program provides the hardware necessary to conduct microgravity experiments, for example, onboard the Shuttle.

Shuttle/Spacelab Payload Mission Management and Integration used to be a line item within the Physics and Astronomy budget and now is included in the reorganized Life and Microgravity Sciences. This line item would increase 25 percent for a total request of $117.7 million. This request includes funds for the third ATLAS mission; a series of Spacelab missions; and the second flight of the International Microgravity Laboratory, among others. Funds will also be used to prepare for the joint US/Russia Spacelab-Mir mission.

*Mission to Planet Earth* now includes the Earth Science program, Information Systems, Research Operations and Support, and a part of the Communications program. In FY 1994 Mission to Planet Earth would increase $121 million (12.1 percent) to $1.075 billion. Thirty percent of the request will go to the Earth Observing System (EOS) for a total of $322.7 million. The restructured EOS program includes three flight missions: AM series ($200 million), PM series ($58.2 million), and the Chemistry series ($1.5 million). The EOS series is designed to conduct measurements over a fifteen-year period.

The second largest funding portion of Mission to Planet Earth is the Earth Observing System Data Information System (EOSDIS), which will provide data processing support for EOS science data. In FY 1994 EOSDIS would increase 40 percent to $182.7 million.

## Space Research and Technology

Space Research and Technology used to be included with the aeronautics portion of NASA's R&D budget. Under Dan Goldin's leadership this area was merged with Commercial Programs into a new office entitled Advanced Concepts and Technology. The focus of this new office is "to support the development and application of technologies critical to the economic, scientific, and technological competitiveness of the US."

The budget request for Space Research and Technology (SR&T) was increased 9.3 percent over FY1993 to $298 million. The goal of this area is to provide advanced, enabling technologies for future space missions. SR&T is divided into two areas: (1) Research and Technology Base, which received a minor increase of less than two percent for a total request of $160.8 million; and (2) Civil Space Technology Initiative (CSTI), which received a budget request of $137.4 million, almost 20 percent over FY 1993.

## Commercial Programs

Commercial Programs received a 4 percent increase from the Administration in FY 1994, growing from $165.4 million to $171.6 million. Commercial Programs is separated into two subcategories:

*Technology Transfer:* The budget request in this area was decreased $2.6 million (8.9 percent) to $26.9 million. This subcategory was previously known as Technology Utilization and is set up to assist the transfer and application of aerospace technology to the public and private sector.

*Commercial Use of Space:* The budget request in this area was increased 6.8 percent for a total request of $145.1 million in FY1994. The largest portion of this program goes to Commercial Transportation which would increase almost 23 percent for a total request of $91.1 million; $66.5 million of this request will go towards the Commercial Middeck Augmentation module. In addition, funding will support the second flight of the Commercial Experiment Transporter (COMET) scheduled for FY1994.

## Aeronautical Technology

Requested funding in this area increased from $865.6 million to $1.100 billion (27 percent) in fiscal year 1994. Much of this increase is due to a request for funding of transatmospheric research and technology, which had been deleted by Congress in FY1993. However, aeronautics has been given renewed attention by NASA in recognition of the impact that commercial aviation has on our economy, trade, and employment. Both NASA and Congress are expected to carry a strong interest in maintaining US leadership in this discipline.

*Aeronautics Research and Technology* carries the largest portion of the proposed budget with a request of $1.020 billion, an increase of almost 18 percent over FY1993. NASA plans to increase the budget in this area more than 55 percent over FY1993 within the next five years. Systems Technology Programs received the biggest boost, and could grow almost 53 percent to $428.9 million. The majority of this requested increase goes toward high speed research ($187.2 million), and advanced subsonic technology ($101.3 million). These are two key elements of NASA's plan to push aeronautical technology.

It should be noted that augmentations to aeronautical technology have been designated to the New Technology Investments category merged with the Space Station Program. Whether this means that specific augmentations to aeronautical programs outlined in the proposed budget are contingent to the redesign effort or whether it means that programs may receive additional funds after the redesign is unclear.

*Transatmospheric Research and Technology* had been deleted by Congress in FY 1993, and NASA is again requesting $80 million in funds for FY1994. In past years funding in this area had gone towards supporting the joint DOD/NASA National Aerospace Plane Program. NASA's portion of this program has been restructured to emphasize hypersonic propulsion systems, and funding in FY1994 will be used for testing a ramjet-scramjet engine.

## Safety, Reliability and Quality Assurance

The Administration requested a 7.9 percent increase in this area for a total of $35.3 million. The program's objective is "to assure the safety and quality of NASA missions." Elements of the program include developing technical standards; demonstrating key technologies; system analyses; and quality assurance.

## Academic Programs

The request for NASA's Academic Programs was reduced almost 20 percent, decreasing from $92.9 million in FY1993 to $74.5 million. However, the entire decrease is due to a request for zero funding under Special Projects. This was a program specifically directed by Congress to be included in the FY1993 budget only. Special Projects was funded at $19.4 million in FY1993.

## Tracking and Data Advanced Systems

The request for this area was increased $1.3 million for a total of $24.6 million in FY 1994. Funding will go towards the Advanced Systems Program which is designed "to improve the performance, capability, and reliability of future space missions in the critical areas of communications, navigation, and mission operations."

# 10

# R&D in the Department of Agriculture

*James W. Cowan, Elizabeth Allred, NASULGC*

## HIGHLIGHTS

- National Research Initiative ($130.195 million, an increase of $33 million)
- Forestry Research Initiative ($194.4 million, an increase of $10 million)
- Advanced Materials ($45.8 million, an increase of $8.4 million)
- Global Change ($47.6 million, an increase of $1.6 million)
- Advanced Manufacturing ($50.0 million, an increase of $9.4 million)
- Biotechnology ($190.7 million, a decrease of $19 million)
- Biofuels ($12.5 million, an increase of $3.8 million)
- New Uses for Agricultural Commodities ($130.8 million, an increase of $16.8 million)
- Human Nutrition Research ($66.5 million, an increase of $2.8 million)
- Food Safety ($72.7 million, a decrease of $800,000)
- Water Quality ($87.6 million, a decrease of $1.4 million)

The total budget proposed for USDA in FY1994 is $67.548 billion, a decrease of just over $598 million from the 1993 current estimate of $68.146 billion. Of the total proposed budget, $1.335 billion is for research and development, a decrease of $37 million from the 1993 current estimate of $1.372 billion. The principal research and development activities of USDA are found within the Agricultural Research Service (ARS), Alternative Agricultural Research and Commercialization (AARC), the Cooperative State Research Service (CSRS), the Economic Research Service (ERS) and the Forest Service (FS). The funding levels for each individual agency is as follows:

**Figure 1.** Total USDA R&D (In Millions)

| | 1991 Actual | 1992 Actual | 1993 Current Estimate | 1994 President's Request |
|---|---|---|---|---|
| ARS | 606.3 | 644.5 | 642.4 | 657.7 |
| AARC | -- | 4.5 | 7.2 | 20.0 |
| CSRS | 372.7 | 507.5 | 485.1 | 431.4 |
| ERS | 54.8 | 59.3 | 59.3 | 51.8 |
| FS | 186.0 | 180.5 | 185.7 | 194.4 |
| Total | 1,219.8 | 1,396.3 | 1,379.7 | 1,355.3 |

## USDA INITIATIVES

### National Research Initiative

The National Research Initiative (NRI) is the centerpiece of CSRS's funding mechanisms. Through the competitive grants process, at a proposed level of $130.195 million, it seeks to fund top scientists in six major categories: natural resources and environment ($26 million); plant systems ($45.2 million); animal systems ($30 million); nutrition, food quality and health ($13 million); processes and new products ($9 million); and markets, trade and rural development ($7 million). The President's FY1994 budget request reflects an increased interest in environmental, health and nutrition concerns confronting both producers and consumers, as well as additional research to meet the challenges of a changing rural America.

### Forestry Research Initiative

In an effort to widen the scope of forestry research in the Forest Service, an additional $10 million dollars is proposed within a $194.4

million funding request for research in forestry ecosystem management. This research would help to increase the scientific capacity to aid in the development of sound policies for forest management and production. In addition, an increase of $8.5 million is sought for the Cooperative Forestry Research program in CSRS for a potential of $28 million in total funding. These funds are distributed to participating universities on a formula basis. The recommended increase would also support research in forestry ecosystem management.

## Advanced Materials

Ten federal agencies are participating in the Advanced Materials and Processing Program as coordinated by the Federal Coordinating Council for Science, Engineering and Technology (FCCSET). This programs seeks to assist in the development of improved materials to meet both industrial and consumer demands. USDA's role will be to involve university and private industry research scientists to advance the materials science of agricultural and forestry commodities. Such materials would include plastics, nylons and fluids from crops. Proposed funding: ARS–$32.8 million; AARC–$8 million; CSRS–$3 million; FS–$2 million.

## Global Change

USDA's global change research attempts to better understand the response of crops, water and soils to climate changes. Agencywide efforts include data collection programs which provide essential information for increased understanding. Other funding increases are proposed for research in atmospheric carbon dioxide, methane and nitrous oxides from forest land conversion, livestock and rice production, and the application of chemical nitrogen fertilizers. Proposed funding: ARS–$10.1 million; CSRS–$12.9 million; ERS–$0.8 million; FS–$22.3 million.

## Advanced Manufacturing

Taking part in another coordinated governmentwide program to increase cooperation between government and industry, USDA will focus its efforts in developing agricultural and forestry commodities as inputs for the manufacture of consumer and industrial products. Part of the ARS endeavor will be the development of technology to improve farm production efficiency through the integration of biological, engineering and economic models. Funding for AARC would allow for more development and commercialization of new processing technologies in cooperation with private industry. Proposed funding: ARS–$42.3 million; AARC–$2.4 million; CSRS–$2.9 million; FS–$2.4 million.

## Biotechnology

Funding for biotechnology would support increased use of new biotechnologies and their application in addressing problems facing both producers and consumers. Included in the funding of this program is $1.7 million for research on biotechnology risk assessment. Proposed funding: ARS–$115.3 million; CSRS–$66.7 million; ERS–$0.2 million; FS–$8.5 million.

## Biofuels

An increased supply and use of biofuels would respond to environmental concerns as well as increasing the market for some agricultural commodities, thereby improving farm income and lowering farm program costs. Additionally, decreased dependence upon a foreign fuel supply also increases America's energy security.

Proposed funding: ARS–$4.5 million; AARC–$4 million; CSRS–$2.6 million; ERS–$1.1 million; FS–$0.3 million.

## New Uses for Agricultural Commodities

The development of new uses for agricultural commodities can greatly improve farm income by providing new food and fiber commodities for domestic use and export. New value-added uses will augment U.S. competitiveness in the global economy as well as provide new economic opportunity for rural America. Proposed funding: ARS–$79.1 million; AARC–$16 million; CSRS–$25.5 million; ERS–$0.1 million; FS–$0.2 million.

## Human Nutrition Research

Part of a larger USDA initiative entitled "Human Nutrition Research, Education, and Monitoring," this research effort would ensure that federal dietary guidance is based on sound science. Proposed funding: ARS–$50.1 million; CSRS–$14.9 million; ERS–$1.5 million.

## Food Safety

The research programs of this agencywide program provide scientific and economic analytic support for the food inspection programs of USDA as well as the development and application of new technologies. Proposed funding: ARS–$36.4 million; CSRS–$9.7 million; ERS–$2.0 million.

### Water Quality

Research and technology development make up two important components of USDA's water quality program. A major research effort continues to concentrate on the midwest corn belt, bringing together multiple research resources from USDA, the states and other federal agencies to work on problems related to corn and soybean production. Proposed funding: ARS–$52.3 million; CSRS–$31.2 million; ERS–$4.1 million.

## USDA AGENCIES

**Agriculture Research Service (ARS)**—ARS serves as the primary research agency of USDA and conducts basic and applied research at federal laboratories. Its research efforts include all departmentwide initiatives described above as well as efficient food and fiber production, groundwater and other natural resource concerns of agriculture, food safety and the development of new uses for agricultural products. Proposed funding for FY1994 is $657.7 million, representing a $15.3 million increase.

**Figure 2.** Agricultural Research Service (ARS)(In Millions)

| | 1991 Actual | 1992 Actual | 1993 Current Estimate | 1994 President's Request |
|---|---|---|---|---|
| Soil and Water Conservation | 73.0 | 81.9 | 82.4 | 83.5 |
| Plant Science | 232.7 | 244.8 | 241.5 | 244.7 |
| Animal Science | 107.8 | 112.5 | 113.6 | 115.1 |
| Commodity Conversion/ Delivery | 121.0 | 127.4 | 129.4 | 137.1 |
| Human Nutrition | 48.3 | 49.9 | 49.7 | 50.1 |
| Integration of Ag'l Systems | 23.5 | 26.0 | 25.8 | 27.2 |
| Total | 606.3 | 644.5 | 642.4 | 657.7 |

**Alternative Agricultural Research & Commercialization (AARC)**—The AARC seeks to bridge the gap between the completion of research and the actual commercialization of the technology. Proposed funding for FY1994 is $20 million, representing a $12.8 million increase.

**Cooperative State Research Service (CSRS)**—CSRS administers federal funds on a formula basis (Hatch Act, 1890 institutions, forestry) which are provided for research at the state agricultural experiment stations and other eligible institutions. CSRS also administers the NRI as well as other competitive grants and special research grants programs. The agency also participates in the nationwide system of research planning and coordination. Proposed funding for FY1994 is $431.4 million, representing a decrease of $53.7 million. The decrease in proposed funding reflects no funding proposals for congressionally initiated research programs.

**Figure 3**. Cooperative State Research Service (CSRS)

| | 1991 Actual | 1992 Actual | 1993 Current Estimate | 1994 President's Request |
|---|---|---|---|---|
| Hatch Act | 162.3 | 168.8 | 168.8 | 173.5 |
| 1890 Colleges and Tuskegee | 26.3 | 27.4 | 27.4 | 28.2 |
| Forestry | 17.9 | 18.5 | 18.5 | 28.0 |
| 1890 Capacity Bldg Grants | 17.9 | 10.3 | 10.3 | 11.5 |
| Critical Ag Mat. | 0.8 | 0.4 | 0.4 | 0.0 |
| Special Research Grants | 23.8 | 73.1 | 73.4 | 34.4 |
| NRI | 73.0 | 97.5 | 97.5 | 130.2 |
| Animal Health | 5.5 | 5.6 | 5.6 | 0.0 |
| Alternative Crops Research | 1.2 | 1.2 | 1.2 | 3.0 |
| Sustainable Ag | 6.7 | 6.7 | 6.7 | 6.9 |
| State Ag Weather Information | 0.0 | 0.4 | 0.4 | 0.0 |
| IPM | 4.0 | 4.5 | 5.0 | 7.0 |
| Pest. Clearance | 3.0 | 3.5 | 3.5 | 10.0 |
| Pesticide Impact Assessment | 3.0 | 3.0 | 3.0 | 3.0 |
| Minor Use Animal Drugs | 0.4 | 0.5 | 0.5 | 0.7 |
| Biological Impact Assessment | 0.3 | 0.3 | 0.3 | 0.3 |
| Rural Dev Ctrs | 0.5 | 0.5 | 0.5 | 0.5 |
| Tropical/Subtropical Agriculture | 3.3 | 3.3 | 3.3 | 0.0 |
| Water Quality | 8.0 | 9.0 | 9.0 | 9.0 |
| Global Change | 0.0 | 2.0 | 2.0 | 3.0 |
| Rangeland | 0.5 | 0.5 | 0.5 | 0.5 |
| Aquaculture Ctrs | 3.7 | 4.0 | 4.0 | 4.1 |

**Economic Research Service (ERS)** — ERS performs economic and other social science research, outlook forecasting and policy analysis related to U.S. and international agriculture, food, production resources and rural America. Proposed funding for FY 1994 is $51.8 million, representing a decrease of $7.5 million.

**Forest Service (FS)** — The Forest Service conducts and disseminates research through eight regional forest experiment stations and the Forest Products Laboratory. Its principal responsibility is management of the National Forest System. Its research responds to this responsibility as well as developing the knowledge and technology to enhance the economic and environmental values of the U.S. forests and related industries. If funded, a major thrust in FY 1994 of the FS research would be the emphasis in forestry ecosystem management. Proposed funding for forestry research in FY 1994 is $194.4 million, representing an increase of $8.7 million.

# 11

# R&D in Selected Agencies

*Kathleen M. Gramp, AAAS*

## HIGHLIGHTS

- The rapid expansion proposed for NIST's Advanced Technology Program and intramural R&D would boost R&D funding at the Department of Commerce to $880.6 million, up 20.3 percent over FY 1993. NOAA would receive an additional 7.3 percent for R&D, primarily for climate research and weather systems acquisition.
- The President would expand R&D on "smart highways," high-speed ground transportation, and aviation systems, raising funding for R&D at the Department of Transportation by 14.0 percent to $715.8 million.
- The Department of the Interior is creating a new National Biological Survey (NBS), an independent science bureau comprised mostly of R&D now done under seven departmental units. Interior's $643.7 million R&D request amounts to an average gain of 4.6 percent, because flat funding for USGS and cutbacks at the Bureau of Mines would partially offset the double-digit growth proposed for NBS-related R&D.
- EPA's $547.9 million request (up 7.1 percent) emphasizes multimedia assessments of risks and trends and the development of innovative environmental technologies. Discon-

tinuing congressionally earmarked projects would result in lower funding for most media-related R&D programs.

## DEPARTMENT OF COMMERCE

R&D at the Department of Commerce is gaining ground within the federal R&D portfolio and within the department itself (see Table II-14). In FY1990, R&D represented only 12 percent of the department's budget, and less than one percent of federal R&D spending. At the $880.6 million level proposed by the President, R&D would double its share of both. This surge primarily reflects the growing support for R&D at the ***National Institute of Standards and Technology*** (NIST). If Congress approves the agency's $450.6 million request, NIST's R&D budget would be double its FY 1992 level.

Heeding the recommendations of various blue-ribbon panels, the Administration has proposed a rapid expansion—a tenfold increase over the next four years—for NIST's extramural Advanced Technology Program (ATP). The ATP supports R&D on pre-competitive generic technologies selected by the private sector, which shares in both the risk and cost of the research. Awards are made on a competitive basis directly to businesses and joint ventures. Universities, federal labs, and other research institutions may receive funding only through the private sector recipients. Because of the limited funding in past years, the success rate of proposals thus far has averaged about 1 percent.

The $187.8 million requested for R&D in FY 1994 would nearly triple the amount appropriated for this year. NIST has reported that maintaining funding at the FY 1993 level would only be sufficient to sustain existing grants, which are projected to total about 80 by the end of the year. If Congress approves the proposed increase, the agency would conduct two additional open competitions (projected to result in another 100 awards) and two other competitions focused on broad technology areas (projected to yield 20 more awards).

NIST's intramural R&D would grow at a pace that would double its budget within the next four years. The $201.1 million proposed for R&D under the "Scientific and Technical Research and Services Program" (up 23.9 percent) would provide real, inflation-adjusted increases for all areas except physics research.

Most of NIST's current and proposed intramural spending supports FCCSET initiatives.[1] For example, over half of the new money would be invested in R&D on computer systems for the development of standards and protocols for an "information super-highway" and other priorities (providing a threefold increase to $31.5 million). The $36.4 million proposed for Materials R&D would support efforts to improve models, sensors, and process controls for synthesizing, processing, and manufacturing various advanced materials (up 23.9 percent). The additional money requested for Chemical R&D (up 18.2 percent to $21.8 million) reflects support for biotechnology and environmental technologies, while the growth in Electronics and Electrical R&D (up 15.5 percent to $29.7 million) is tied to the needs of that sector.

There would be a one-year dip in funding for the upgrade of NIST's laboratory facilities (from $105.0 million in FY 1993 to $61.7 million in FY 1994), as the agency awaits the completion of architectural and engineering plans. The Clinton Administration has endorsed NIST's ten-year plan to spend a total of $540 million to improve its labs in Gaithersburg, Maryland and Boulder, Colorado.

If NIST gets its requested funding, it would edge out the ***National Oceanic and Atmospheric Administration*** (NOAA) as Commerce's largest R&D agency. NOAA has requested $424.3 million for R&D, a 7.3 percent gain over FY 1993. This amounts to a net increase of $29 million, of which $19.2 million would be invested in R&D on the Advanced Weather Interactive Processing System for the National Weather Service. The Weather Service's overall request of $55.1 million would raise funding for its research programs by 3.1 percent.

In its $157.7 million request for Oceanic and Atmospheric Research (OAR, up 13.7 percent), NOAA would try once again to expand its direct funding for climate and air quality research. For the last three years, appropriations for NOAA's global change R&D have hovered near $43 million. In FY1993, about $19 million of the amount appropriated to the State Department is being made available to NOAA for global change, providing the program with a total of $62 million. Thus, NOAA's FY 1994 request of $63.6 million for climate and global change R&D would involve a 49.1 percent increase in its own appropriation, but only a 3 percent gain in overall resources.

Included in the OAR request is a 21.4 percent increase for long-term climate and air quality research (to $26.7 million) for R&D pertaining to the Clean Air Act and advanced software and computer networking. OAR's budget for weather research would inch up 2.1

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[1] NIST supports the following Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) initiatives: High Performance Computing and Communications, Advanced Materials and Processing, Advanced Manufacturing, and Biotechnology.

percent to $27.7 million, despite the proposed termination of federal-state weather modification grants. On the other hand, NOAA would cut funding for OAR's politically popular marine research programs. Undersea Grants would be reduced to $3.6 million (down 54.4 percent), Sea Grant research to $13.1 million (down 9.6 percent), and Marine Prediction R&D to $16.4 million (down 8.2 percent).

In a break from previous years, NOAA is requesting a slight increase in appropriations for R&D at the National Marine Fisheries Service (NMFS, $110.3 million). Citing the need for scientific expertise in fulfilling its fisheries conservation and management responsibilities, NOAA has proposed a 4.6 percent increase for Resource Information research, for a total of $78.2 million. Appropriations for NMFS's other fisheries management and industry-related research would be continued at FY 1993 levels. However, because the Administration would not allocate any of the money collected from customs receipts for R&D, the total funding available for NMFS R&D would fall 2.2 percent relative to FY 1993.

NOAA has proposed spending $19.2 million for R&D at the National Ocean Service (NOS), $0.9 million or 4.5 percent less than in FY 1993. NOAA attributes the cuts in Observations and Prediction R&D and Coastal Ocean Science to the completion or elimination of low priority projects. Most other NOS research programs—Esturine and Coastal Assessment[2], Coastal and Ocean Management, Mapping and Geodesy—would be continued at their current levels. Funding for NOAA's R&D facilities would drop 21 percent because of lower expenditures on fleet modernization and construction.

## DEPARTMENT OF TRANSPORTATION

Reflecting an emphasis on upgrading the nation's infrastructure, the Clinton Administration has proposed spending $715.8 million on R&D at the Department of Transportation (DOT), a 14.0 percent increase over FY 1993. (See Table II-15.) The department estimates that $46.4 million of the FY 1994 funding would go to universities, with most of the balance supporting intramural and industrial researchers.

About 40 percent of DOT's R&D budget is for the ***Federal Aviation Administration*** (FAA), which has requested $297.2 million for FY 1994 (up $16.0 million, or 5.7 percent). Noting the 25 percent growth in aircraft operations projected over the next ten years, the President has proposed spending $76.9 million for R&D on technologies to modernize air traffic control and manage aviation capacity (up 15.0 percent). Double-digit increases also have been suggested for R&D on aircraft safety ($41.2 million, up 12.6 percent); communications, navigation, and surveillance ($35.7 million up 11.2 percent); airport technology ($7.5 million, up 13.4 percent); energy and environmental R&D ($5.4 million, up 13.4 percent); and innovative and cooperative R&D ($4.7 million, up 13.1 percent). Among the exceptions to this pattern are weather-related R&D, which would drop to $1.9 million (down 68.8 percent) and the requests for FAA's R&D facilities and management (down 9.7 percent and 5.4 percent, respectively).

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[2] NOAA has revised its estimates of R&D done under these lines, and no longer classifies most of the Status and Trends program as R&D.

DOT's second largest research agency, the ***Federal Highway Administration*** (FHWA), has requested $267.8 million for R&D in FY 1994, a 17.9 percent increase over FY1993. The President would more than triple funding for R&D on intelligent vehicles-highway systems (IVHS). The $65.1 million proposed for IVHS in FY 1994 would support R&D on artificial intelligence, machine vision, and other advanced technologies. To finance this initiative, the President is asking Congress to allocate $17.0 million under FHWA's operating account (the same as this year), and one quarter of the $183 million proposed for all IVHS activities under the Highway Trust Fund for R&D (or $47.1 millon).[3] Last year appropriators allocated all of the IVHS money in the Trust Fund account to non-R&D projects.

Apart from IVHS, the only increase proposed by FHWA would be to restore funding for R&D on long-term pavement performance to its FY 1992 level of $10 million (up $4 million). With few exceptions, FHWA's other R&D programs, including University Transportation Centers, would be continued at their FY 1993 levels. Among those targeted for cutbacks are Eisenhower Fellowships (down 33.7 percent), and Highway Research, Development, and Technology (down 11.1 percent to $42.7 million). The $1.5 million federal Strategic Highway Research Program would be terminated.

The Highway Trust Fund would provide most of the money for the doubling of R&D at the ***Federal Railway Administration*** (FRA). Out of the $63.2 million requested for R&D in FY1994, $18.2 million would be appropriated for FRA's traditional research missions, such as rail safety, performance, components, and structures. The balance would come from the Highway Trust Fund for the development of technologies for high-speed ground transportation systems for medium range (100-500 mile) intercity corridors. FRA has requested $27.9 million for the first phase of an advanced magnetic levitation train prototype. Another $10 million would be used to pursue technologies for high-speed rail passenger service on existing transportation systems, if legislation is enacted to authorize such projects. The remaining funds would cover other R&D expenses.

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[3] Most of the funding for the FHWA's R&D comes from the Highway Trust Fund. Expenditures from the fund are controlled by authorization statutes and annual obligation limits set in appropriation laws. The amounts shown for R&D reflect the obligation limits in those cases.

## DEPARTMENT OF THE INTERIOR

Changes are in the offing for R&D at the Department of the Interior (DOI), but the budget numbers only tell part of the story. The bottom line for R&D is projected to increase modestly, rising 4.6 percent to $643.7 million. What is changing is the focus and structure of Interior's biological research, most of which will be folded into a new ***National Biological Survey*** (NBS) beginning in FY 1994.

As described by Secretary of the Interior Bruce Babbitt, the creation of the NBS

> is aimed at filling the vacuum that currently exists for broad scale biological information and assessments of the Nation's natural resources. Science, in the context of the NBS, includes traditional research (including that carried out in cooperation with state agencies and universities) as well as inventorying and monitoring to identify status and trends, and information transfer.[4]

The NBS is being established administratively with the assistance of the Smithsonian Institution and National Academy of Sciences. It will involve the transfer of nearly 1,600 federal scientists and related personnel and the $179.4 million requested for such functions in FY 1994. Of the sums projected for the NBS, an estimated $151.9 million would support R&D previously funded in seven of Interior's existing bureaus. As an independent science bureau, the NBS will have no regulatory or management responsibilities, but will have its priorities guided by the needs of resource managers.

As shown on Table II-16, R&D at the NBS would mostly be comprised of research currently conducted by the Fish and Wildlife Service (FWS, $109.1 million), National Park Service (NPS, $31.4 million), Bureau of Land Management (BLM, $8.2 million), and Bureau of Reclamation ($1.7 million). The amount proposed for

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[4] Department of the Interior, *Budget Justifications, FY 1994, National Biological Survey*, p.1.

R&D represents an increase of roughly 20 percent over FY1993 levels, based on trends for the components being merged into the NBS. Because the plan will move most of the "cooperative units" to the NBS, it is likely that the $28.5 million projected for university research at FWS, NPS, and BLM will come under its purview.

Research at the NBS would be clustered around five major themes. In FY1994, the NBS would devote $47.4 million to Ecosystems research, including expanded research on the landscape functions of ecosystems, the ecological impacts of contaminants, habitat conditions of large rivers, and southern forested wetlands. Another $30.6 million would support Inventorying and Monitoring R&D, some of which would be used to integrate existing biological profiles, expand the Gap Analysis Project for plant and animal communities, and establish an Aquatic Gap Analysis Project. Species Biology would receive $21.3 million for basic species-level research, with increases proposed for R&D on genetics and systematics, endangered plants, and the effects of drugs and chemicals used in aquaculture. Among the issues emphasized in the $14.7 million request for R&D on Population Dynamics are population viability and methods to monitor and inventory populations of amphibians, reptiles, mammals, and neotropical birds.

To some extent, the NBS is being modeled after Interior's largest research arm, the ***U.S. Geological Survey*** (USGS). Out of the $598.0 million requested for USGS for FY1994, the agency estimates that $378.2 million would support R&D. At these levels, funding for the Survey's R&D would receive 5.4 percent more than was appropriated for FY1993. The agency would direct the additional $19.4 million toward three management and legislative priorities: water quality assessments, geologic mapping, and facilities for national data base management.

USGS's $119.8 million request for Water Resource Investigations (up $9.2 million, 7.7 percent) would target Water Quality Assessments. The agency has proposed adding $12.8 million for these studies (up 37.1 percent), while cutting funding for nuclear waste hydrology, regional aquifer system analysis, and data collection and analysis. USGS would use the added money to evaluate the status and trends of 20 additional study units (riverbasins and aquifer systems) to assist federal, state, and local resource managers. Support for university research under the Water Resources Research Institutes program would be frozen at the FY 1993 level of $5.5 million. Funding for cooperative federal-state research programs also would be unchanged.

There is only one policy change in the $221.0 million request for R&D on geologic and mineral resources. Responding to new statutory mandates to expedite the acquisition of geologic data and maps, USGS has asked for an additional $1.0 million for Geologic Mapping R&D. Funding for all other areas would decline slightly, because of downward adjustments in the projected costs of current programs. These revisions more than offset the increase for mapping, resulting in a net loss of $1.3 million for geologic and minerals R&D (down 0.6 percent). Corresponding to the stagnation in overall funding, the agency expects support for universities in geologic R&D to remain at $20 million in FY 1994.

USGS's smallest R&D program, National Mapping, Geography and Surveys, would receive the largest increase in FY 1994 (up 11.5 million to $37.3 million, a 30.9 percent gain). An additional $12.6 million has been requested to support the construction of an addition to the Survey's EROS Data Center to handle land-related data from NASA's Earth Observing System and Landsat 7. Because of fiscal pressures resulting from this and other departmental initiatives, the agency proposed a 10.3 percent cut in funding for R&D on Advanced Cartographic Systems.

Other departmental R&D linked to minerals development and management would be deemphasized under the Clinton plan. Hardest hit would be R&D at the ***Bureau of Mines***, for which the department has recommended $89.7 million, an 18.2 percent drop from current levels. The Administration would terminate support for university Mineral Institutes, and reduce funding for R&D on technologies for health, safety, and mining, and on minerals and materials. Among Bureau programs, only Environmental Technology would be increased (up $1 million to $18.0 million). Finally, the Administration would freeze funding at the FY 1993 level for R&D at the ***Minerals Management Service*** ($6.0 million) and ***Office of Surface Mining, Reclamation, and Enforcement*** ($1.9 million).

## ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) may obtain cabinet status under the Clinton Administration without the benefit of additional resources. Because of proposed reforms in EPA's infrastructure and cleanup programs (*e.g.*, wastewater, Superfund, and facilities), the agency's $6.4 billion request for FY 1994 is 7.8 percent below the FY 1993 level. Relative to EPA's other programs, R&D would fare well: the $547.9 million request for R&D amounts to a 7.1 percent gain over the current level (see Table II-17). However, the agency's R&D figures exclude the $27.9 million requested under the Superfund program for R&D at the National Institute for Environmental Health (down 46.2 percent) and the roughly $30 million appropriated in FY 1993 for congressionally earmarked R&D facilities at nonfederal sites (down 100 percent).

EPA's request for R&D involves cutbacks in virtually all of the media-related R&D programs. What most of those reductions reflect is the agency's policy not to continue funding congressionally directed projects in FY 1994. Appropriators earmarked about $33 million of EPA's FY 1993 R&D budget (excluding facilities), and the agency would drop all but the $3 million channeled to Clark University. If the earmarks are taken out of the picture, the FY 1994 outlook turns mildly positive for Air Quality, Water Quality, Drinking Water, and Toxic Substances R&D. Funding for Superfund and Pesticides R&D would drop by a more modest 3.8 percent and 1.4 percent, respectively. Similarly, the request for Hazardous Waste R&D would be about 2.8 percent below this year's level after adjusting for earmarks and the transfer of oil spill R&D activities to a trust fund.

Another technicality that skews the media profile is EPA's effort to redirect resources toward "multimedia" R&D. To some extent, this involves shifting research now done under "media" programs to the Multimedia budget. While the exact amounts being transferred cannot be determined in the absence of data from EPA, the reorganization may distort the year-to-year trends for the individual lines.

The tilt toward Multimedia R&D reflects the Administration's emphasis on integrated, risk-based environmental strategies. Several areas of research would be accorded priority under this approach. First, EPA would expand interdisciplinary R&D on fundamental environmental processes and trends. The agency has requested $42.5 million for the interagency Environmental Monitoring and Assessment Program (up 6.1 percent), which is profiling and evaluating the status and trends of major ecological areas. Agencywide funding for ecological risk assessments would jump 83.6 percent to $19 million, allowing an expansion of extramural research, an integration of federal ecological research, and the development of "holistic" analyses and tools for various media-related programs.[5]

Another priority is "green designs" that focus on process rather than tailpipe solutions to pollution problems. EPA has requested a sixfold increase for "innovative technologies," bringing the agencywide request to $40.7 million. About 70 percent of the total for would go to the Multimedia program ($28.7 million) for R&D emphasizing cost-effective advanced manufacturing processes that minimize pollution. Another $4.8 million would be budgeted under the Hazardous Waste program's Abatement and Control (A&C) appropriation for interagency and private sector initiatives in such areas as monitoring, incineration, characterization, and restoration. The A&C request for Toxic Substances proposes $3.6 million to encourage industry to include environmental parameters in the design of products and processes. A similar amount is proposed for A&C efforts of the Office of International Affairs, which would focus on the potential for transferring environmental technologies abroad, especially in developing countries.

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[5] Of the $19 million proposed for ecological risk assessments, $11.5 would come under Multimedia and the remainder under the media programs (e.g., Pesticides, Toxic Substances, Hazardous Waste, and Superfund).

Additional support would be provided for investigator-initiated research and for EPA's own labs. The $26.5 million requested for Multimedia Grants and Centers amounts to a 4.8 percent increase over FY 1993, despite the plan to discontinue the $0.8 million earmarked for the Experimental Program to Stimulate Competitive Research (EPSCoR). The $49.2 million request for Lab and Field Expenses (up 22.6 percent) would be spent on lab operating expenses and improvements, the acquisition of a "massively parallel" computer, and an interconnection with computer centers in Michigan and North Carolina.

Shifting some programs to the Multimedia budget may involve a reorientation of research rather than a change in the agency's overall effort. For example, EPA would expand research on human exposure, but would offset that increase by reducing the amount spent on health effects and risk assessments. Funding for both technology transfer and environmental education would remain at current levels.

Viewing funding by issue also highlights media-related programs that would gain funding despite the loss of earmarked money. Examples include criteria air pollutants ($43.6 million, up 5 percent); global change ($27.5 million, up 6.2 percent); drinking water pollutants and disinfectants ($14.6 million, up 6.1 percent); and wetlands ($3.8 million, up 3.8 percent). EPA also wants to spend $1.0 million on lead and heavy metals under the Toxic Substances R&D, which would bring the agencywide total to $4.2 million (up 31.2 percent, including Multimedia funding).

Some of the money needed to pay for these increases would come from cuts made in other issue areas. Under the Administration's request, funding for Acid Deposition R&D would drop to $10.9 million in FY 1994 (down 30.6 percent, including the effects of a $1 million earmark). Even after adjusting for earmarks, the EPA request assumes fewer dollars for R&D on municipal solid waste, surface cleanup technologies, motor vehicle emissions, indoor air pollution, nonpoint sources, contaminated sediments, aquatic ecosystems, and the review of new chemicals under the Toxic Substances and Pesticides programs.

Finally, the FY 1994 budget assumes that the workforce associated with EPA's R&D programs would drop by nearly 28 full-time equivalent positions. About 20 of those positions may be lost because of the cuts proposed in the Acid Deposition program.

# Agency Tables

# TABLE II-1. FY 1993 R&D BY AGENCY

**Table II-1.** R&D in the FY 1994 Budget by Agency (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change Current | FY 1993–94 Constant |
|---|---|---|---|---|---|
| **Total R&D (Conduct and Facilities)** | | | | | |
| Defense (military) | 37,779.0 | 39,064.9 | 39,504.1 | 1.1% | -1.9% |
| NASA | 8,544.2 | 8,847.1 | 9,546.3 | 7.9% | 4.7% |
| Energy | 8,133.4 | 7,391.0 | 7,528.4 | 1.9% | -1.2% |
| HHS | 10,179.7 | 10,485.3 | 10,832.2 | 3.3% | 0.2% |
| NIH 1/ | (9,624.3) | (9,890.2) | (10,207.9) | 3.2% | 0.1% |
| NSF | 1,971.7 | 2,008.6 | 2,402.3 | 19.6% | 16.0% |
| Agriculture | 1,519.2 | 1,468.5 | 1,438.8 | -2.0% | -5.0% |
| Interior | 642.9 | 615.1 | 643.7 | 4.6% | 1.5% |
| Transportation | 621.1 | 627.8 | 715.8 | 14.0% | 10.6% |
| EPA | 492.5 | 511.4 | 547.9 | 7.1% | 3.9% |
| Commerce | 583.3 | 731.7 | 880.6 | 20.3% | 16.7% |
| Education | 166.9 | 168.0 | 178.0 | 6.0% | 2.8% |
| AID | 373.1 | 372.7 | 332.8 | -10.7% | -13.4% |
| Veterans Affairs | 249.5 | 253.3 | 235.5 | -7.0% | -9.8% |
| Nuclear Reg. Comm. | 119.0 | 119.7 | 122.1 | 2.0% | -1.0% |
| Smithsonian | 110.0 | 114.4 | 113.8 | -0.5% | -3.5% |
| Tennessee Valley Auth. | 104.8 | 113.0 | 81.7 | -27.7% | -29.9% |
| Corps of Engineers | 56.2 | 49.6 | 56.4 | 13.9% | 10.5% |
| Labor | 61.6 | 62.0 | 64.4 | 3.9% | 0.8% |
| HUD | 25.0 | 23.3 | 35.0 | 50.2% | 45.7% |
| Justice | 43.2 | 41.1 | 41.6 | 1.2% | -1.8% |
| Treasury | 11.9 | 13.9 | 11.9 | -14.2% | -16.8% |
| Postal Service | 152.5 | 93.9 | 98.3 | 4.7% | 1.5% |
| TOTAL R&D | 71,940.7 | 73,176.2 | 75,411.8 | 3.1% | 0.0% |
| Defense | 41,231.3 | 42,319.0 | 42,520.1 | 0.5% | -2.5% |
| Nondefense | 30,709.4 | 30,857.2 | 32,891.7 | 6.6% | 3.4% |
| **Conduct of R&D** | | | | | |
| Defense (military) | 37,418.3 | 38,792.8 | 39,301.4 | 1.3% | -1.7% |
| NASA | 7,712.0 | 8,002.6 | 8,666.5 | 8.3% | 5.0% |
| Energy | 6,471.2 | 5,997.6 | 6,098.5 | 1.7% | -1.4% |
| HHS | 10,058.8 | 10,369.0 | 10,703.5 | 3.2% | 0.1% |
| NIH 1/ | (9,503.4) | (9,773.8) | (10,079.2) | 3.1% | 0.0% |
| NSF | 1,870.2 | 1,870.7 | 2,217.0 | 18.5% | 15.0% |
| Agriculture | 1,334.9 | 1,336.2 | 1,364.9 | 2.1% | -0.9% |
| Interior | 611.5 | 600.0 | 620.0 | 3.3% | 0.2% |
| Transportation | 579.8 | 588.2 | 675.6 | 14.9% | 11.4% |
| EPA | 487.5 | 508.9 | 547.9 | 7.7% | 4.4% |
| Commerce | 544.9 | 589.5 | 783.1 | 32.8% | 28.8% |
| Education | 164.5 | 165.8 | 176.2 | 6.3% | 3.1% |
| AID | 373.1 | 372.7 | 332.8 | -10.7% | -13.4% |
| Veterans Affairs | 245.0 | 250.8 | 223.8 | -10.8% | -13.4% |
| Nuclear Reg. Comm. | 119.0 | 119.7 | 122.1 | 2.0% | -1.0% |
| Smithsonian | 106.2 | 109.4 | 108.8 | -0.5% | -3.5% |
| Tennessee Valley Auth. | 101.2 | 109.9 | 81.6 | -25.8% | -28.0% |
| Corps of Engineers | 56.2 | 49.6 | 56.4 | 13.9% | 10.5% |
| Labor | 61.6 | 62.0 | 64.4 | 3.9% | 0.8% |
| HUD | 25.0 | 23.3 | 35.0 | 50.2% | 45.7% |
| Justice | 43.2 | 41.1 | 41.6 | 1.2% | -1.8% |

# TABLE II-1., continued

**Table II-1 (continued).** R&D in the FY 1994 Budget by Agency (budget authority in millions of dollars)

| | FY 1992 | FY 1993 | FY 1994 | % Change | FY 1993–94 |
|---|---|---|---|---|---|
| | Actual | Est. | Budget | Current | Constant |
| **Conduct of R&D** | | | | | |
| Treasury | 11.8 | 13.8 | 11.8 | -14.5% | -17.1% |
| Postal Service | 152.5 | 93.9 | 98.3 | 4.7% | 1.5% |
| Total Conduct of R&D | 68,548.4 | 70,067.3 | 72,338.7 | 3.2% | 0.1% |
| Defense | 40,083.2 | 41,603.0 | 41,978.1 | 0.9% | -2.1% |
| Nondefense | 28,465.2 | 28,464.3 | 30,353.0 | 6.6% | 3.4% |
| **R&D Facilities** | | | | | |
| Defense (military) | 360.7 | 272.1 | 202.7 | -25.5% | -27.7% |
| NASA | 832.1 | 844.6 | 879.9 | 4.2% | 1.1% |
| Energy | 1,662.2 | 1,393.4 | 1,430.0 | 2.6% | -0.5% |
| HHS | 120.8 | 116.3 | 128.7 | 10.7% | 7.3% |
| NIH 1/ | (120.8) | (116.3) | (128.7) | 10.7% | 7.3% |
| NSF | 101.6 | 137.9 | 185.4 | 34.4% | 30.4% |
| Agriculture | 184.4 | 132.3 | 74.0 | -44.1% | -45.8% |
| Interior | 31.4 | 15.2 | 23.7 | 56.5% | 51.8% |
| Transportation | 41.3 | 39.5 | 40.2 | 1.7% | -1.3% |
| EPA | 5.0 | 2.5 | 0.0 | -100.0% | -100.0% |
| Commerce | 38.5 | 142.2 | 97.5 | -31.4% | -33.5% |
| Education | 2.4 | 2.2 | 1.8 | -18.6% | -21.0% |
| AID | — | — | — | — | — |
| Veterans Affairs | 4.5 | 2.5 | 11.7 | 368.0% | 353.9% |
| Nuclear Reg. Comm. | — | — | — | — | — |
| Smithsonian | 3.8 | 5.0 | 5.0 | 0.0% | -3.0% |
| Tennessee Valley Auth. | 3.6 | 3.1 | 0.1 | -97.6% | -97.6% |
| Corps of Engineers | — | — | — | — | — |
| Labor | — | — | — | — | — |
| HUD | — | — | — | — | — |
| Justice | — | — | — | — | — |
| Treasury | 0.1 | 0.1 | 0.1 | 25.0% | 21.2% |
| Postal Service | — | — | — | — | — |
| Total R&D Facilities | 3,392.3 | 3,108.9 | 3,080.8 | -0.9% | -3.9% |
| Defense | 1,148.1 | 716.0 | 542.0 | -24.3% | -26.6% |
| Nondefense | 2,244.2 | 2,392.9 | 2,538.8 | 6.1% | 2.9% |

Source: OMB data for R&D for FY 1994 and agency budget justifications. Constant dollar estimates based on OMB's GDP deflators.

1/Reflects restructuring of National Institutes of Health (NIH) and the transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) under P.L. 102-321.

# TABLE 11-2. R&D IN THE DEPARTMENT OF DEFENSE

**Table II-2.** R&D in the Department of Defense (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Research, Development, Test, and Evaluation** | | | | |
| Research | 1,145.8 | 1,323.7 | 1,255.9 | -5.1% |
| Exploratory Development | 2,958.5 | 3,596.5 | 3,120.4 | -13.2% |
| Technology Base | 4,104.3 | 4,920.3 | 4,376.3 | -11.1% |
| Advanced Technology Dev. | 6,313.8 | 4,052.6 | 3,607.3 | -11.0% |
| Strategic Programs | 4,239.7 | 6,345.0 | 4,776.0 | -24.7% |
| Tactical Programs | 14,313.3 | 14,130.7 | 15,904.2 | 12.6% |
| Intelligence/Communications | 4,920.7 | 4,702.3 | 5,113.2 | 8.7% |
| Defense-wide Mission Support | 4,224.7 | 4,025.5 | 4,843.3 | 20.3% |
| BA Adjustment | -1493.6 | -2.1 | 0.0 | — |
| TOTAL RDT&E | 36,622.8 | 38,174.1 | 38,620.3 | 1.2% |
| **Other Appropriations** 1/ | 1,156.2 | 890.8 | 883.8 | -0.8% |
| TOTAL DOD R&D | 37,779.0 | 39,064.9 | 39,504.1 | 1.1% |
| Conduct of R&D | 37,418.3 | 38,792.8 | 39,301.4 | 1.3% |
| R&D Facilities | 360.7 | 272.1 | 202.7 | -25.5% |

Source: OMB data for R&D for FY 1994 and *Budget of the United States.*
1/ R&D support in military personnel, military construction, and other DOD appropriations.

# TABLE II-3. DOD R&D BY DEPARTMENTS AND AGENCIES

**Table II-3.** DOD R&D by Military Departments and Agencies (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Research, Development, Test, and Evaluation** | | | | |
| Army | 6,343.5 | 6,015.1 | 5,249.9 | -12.7% |
| Navy | 7,578.5 | 8,933.5 | 9,215.6 | 3.2% |
| Air Force | 12,867.1 | 13,155.6 | 13,695.0 | 4.1% |
| Defense Agencies | 9,610.6 | 9,798.5 | 10,174.5 | 3.8% |
| Strategic Defense Initiative Organization 1/ | 3,906.9 | 3,724.8 | 3,637.1 | -2.4% |
| Advanced Research Projects Agency 2/ | 1,597.3 | 2,250.5 | 2,182.2 | -3.0% |
| Secretary of Defense | 1,424.0 | 1,523.2 | 1,703.9 | 11.9% |
| Defense Mapping Agency | 232.8 | 59.2 | 79.0 | 33.4% |
| Defense Nuclear Agency | 472.6 | 466.4 | 345.4 | -25.9% |
| Defense Support Project | 206.3 | 254.3 | 477.5 | 87.8% |
| Joint Chiefs of Staff | 58.8 | 26.2 | 24.5 | -6.8% |
| Defense Information Systems Agency | 142.9 | 90.1 | 71.8 | -20.3% |
| Defense Logistics Agency | 38.8 | 18.6 | 12.8 | -31.2% |
| Uniformed Services Univ. of the Health Sciences | 3.2 | 4.1 | 0.0 | -100.0% |
| Special Operations Cmnd. | 299.8 | 235.7 | 335.9 | 42.5% |
| Other 3/ | 1,227.3 | 1,145.4 | 1,304.5 | 13.9% |
| Director of Test and Evaluation, Defense | 210.2 | 259.0 | 272.6 | 5.2% |
| Director of Operational Test and Evaluation | 12.8 | 12.3 | 12.7 | 2.6% |
| Total RDT&E | 36,622.8 | 38,174.1 | 38,620.3 | 1.2% |
| Other Appropriations 4/ | 1,156.2 | 890.8 | 883.8 | -0.8% |
| TOTAL DOD R&D | 37,779.0 | 39,064.9 | 39,504.1 | 1.1% |

Source: Department of Defense "RDT&E Programs (R-1)," and OMB data for R&D for FY 1994, and *Budget of the United States Government.*

1/SDIO officially became the Ballistic Missile Defense Organization (BMDO) on May 14, 1993.

2/Formerly the Defense Advanced Research Projects Agency (DARPA).

3/Other includes National Security Agency and Defense Intelligence Agency.

4/R&D support in military personnel, military construction, and other DOD appropriations.

# TABLE II-4. DOD R&D BY CHARACTER OF WORK

**Table II-4.** Department of Defense R&D by Character of Work (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Current Dollars** | | | | |
| Basic Research | 1,145.8 | 1,323.7 | 1,255.9 | -5.1% |
| Applied Research | 2,958.5 | 3,596.5 | 3,120.4 | -13.2% |
| Total Research | 4,104.3 | 4,920.3 | 4,376.3 | -11.1% |
| Development 1/ | 33,314.0 | 33,872.5 | 34,925.1 | 3.1% |
| Total Conduct R&D | 37,418.3 | 38,792.8 | 39,301.4 | 1.3% |
| R&D Facilities | 360.7 | 272.1 | 202.7 | -25.5% |
| TOTAL DOD R&D | 37,779.0 | 39,064.9 | 39,504.1 | 1.1% |
| **Constant FY 1987 Dollars** | | | | |
| Basic Research | 945.4 | 1,064.6 | 979.7 | -8.0% |
| Applied Research | 2,441.2 | 2,892.5 | 2,434.2 | -15.8% |
| Total Research | 3,386.7 | 3,957.1 | 3,413.9 | -13.7% |
| Development 1/ | 27,489.1 | 27,241.8 | 27,244.8 | 0.0% |
| Total Conduct R&D | 30,875.7 | 31,198.9 | 30,658.7 | -1.7% |
| R&D Facilities | 297.6 | 218.8 | 158.1 | -27.7% |
| TOTAL DOD R&D | 31,173.4 | 31,417.8 | 30,816.8 | -1.9% |

Source: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D for FY 1994.

1/Includes expenses of test and evaluation.

# TABLE II-5. DOD BASIC RESEARCH FUNDING

**Table II-5.** Department of Defense Funding for Basic Research (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Army** | | | | |
| Defense Research Sciences | 186.6 | 202.0 | 203.7 | 0.9% |
| In-House Independent Research | 8.8 | 11.7 | 11.0 | -6.6% |
| Electromechanics and Hypervelocity Physics | 2.9 | 3.7 | 3.7 | 0.7% |
| Total Army | 198.3 | 217.4 | 218.4 | 0.4% |
| **Navy** | | | | |
| Defense Research. Sciences | 377.9 | 408.8 | 416.9 | 2.0% |
| In-House Independent Rsrch. | 14.0 | 16.7 | 17.0 | 1.4% |
| Total Navy | 391.9 | 425.6 | 433.9 | 2.0% |
| **Air Force** | | | | |
| Defense Research Sciences | 201.3 | 235.8 | 241.3 | 2.4% |
| In-House Independent Rsrch. | 6.0 | 4.7 | 5.2 | 9.0% |
| Total Air Force | 207.4 | 240.5 | 246.5 | 2.5% |
| **Defense Agencies** | | | | |
| Defense Research Sciences | 115.8 | 109.6 | 81.7 | -25.5% |
| In-House Independent Research | 3.2 | 4.1 | 3.4 | -18.3% |
| Univ. Research Initiative | 219.6 | 317.1 | 242.6 | -23.5% |
| US-Japan Mgmt. Training | 9.6 | 9.4 | 0.0 | — |
| Focused Research Initiatives | 0.0 | 0.0 | 29.5 | — |
| Total Agencies | 348.2 | 440.3 | 357.1 | -18.9% |
| **Total DOD Basic Research** | | | | |
| Defense Research Sciences | 881.6 | 956.2 | 943.6 | -1.3% |
| In-House Independent Research | 32.0 | 37.3 | 36.5 | -2.3% |
| Univ. Research Initiative | 219.6 | 317.1 | 242.6 | -23.5% |
| Electromechanics and Hypervelocity Physics | 2.9 | 3.7 | 3.7 | 0.7% |
| US-Japan Mgmt. Training | 9.6 | 9.4 | 0.0 | -100.0% |
| Focused Research Initiatives | 0.0 | 0.0 | 29.5 | — |
| TOTAL Basic Research | 1,145.8 | 1,323.7 | 1,255.9 | -5.1% |

Source: Department of Defense "RDT&E Programs (R-1)," OMB data for R&D for FY 1994.

# TABLE II-6. DOD R&D TRENDS, FY 1965–1994

**Table II-6.** Trends in Department of Defense R&D, FY 1965 - FY 1994 (in millions of dollars)

|  | Basic Research 1/ |  | Total DOD R&D |  |
|---|---|---|---|---|
| Fiscal Year | Current Dollars | Constant FY 1987 $ | Current Dollars | Constant FY 1987 $ |
| 1965 | 347 | 1,227 | 6,865 | 24,284 |
| 1970 | 323 | 934 | 7,491 | 21,669 |
| 1975 | 305 | 641 | 9,167 | 19,266 |
| 1980 | 552 | 782 | 14,150 | 20,048 |
| 1981 | 615 | 791 | 16,772 | 21,569 |
| 1982 | 697 | 834 | 20,866 | 24,974 |
| 1983 | 787 | 904 | 23,233 | 26,698 |
| 1984 | 843 | 928 | 26,940 | 29,653 |
| 1985 | 851 | 902 | 31,632 | 33,537 |
| 1986 | 954 | 982 | 35,000 | 36,038 |
| 1987 | 894 | 894 | 37,136 | 37,136 |
| 1988 | 897 | 866 | 38,126 | 36,791 |
| 1989 | 951 | 878 | 38,578 | 35,621 |
| 1990 | 936 | 841 | 37,869 | 34,027 |
| 1991 | 1,157 | 982 | 37,209 | 31,594 |
| 1992 | 1,146 | 945 | 37,779 | 31,173 |
| 1993 (Estimate) | 1,324 | 1,065 | 39,065 | 31,418 |
| 1994 (Budget) | 1,256 | 980 | 39,504 | 30,817 |

Source: National Science Foundation historical reports, the R-1, and OMB data on R&D for FY 1994.

Constant dollar conversions based on OMB GDP deflators.

1/ Budget authority for DOD "6.1" category.

# TABLE II-7. NSF R&D

**Table II-7.** R&D in the National Science Foundation (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Research and Related Activities (R&RA)** | | | | |
| Mathematical and Physical Sciences (MPS) | | | | |
| Mathematical Sciences | 78.4 | 77.6 | 88.0 | 13.4% |
| Astronomical Sciences | 112.2 | 103.4 | 113.9 | 10.2% |
| Physics | 138.1 | 128.2 | 142.6 | 11.2% |
| Chemistry | 112.1 | 112.2 | 130.9 | 16.6% |
| Materials Research | 143.5 | 150.7 | 171.0 | 13.5% |
| Major Research Equipment | 38.0 | 47.9 | 72.0 | 50.4% |
| Total MPS | 622.3 | 619.9 | 718.4 | 15.9% |
| Engineering (ENG) | | | | |
| Biological & Critical Sys. | 39.4 | 36.6 | 45.4 | 24.0% |
| Chemical & Thermal Systems | 36.3 | 34.5 | 42.3 | 22.6% |
| Design & Manufacturing Sys. | 22.5 | 26.6 | 32.8 | 23.5% |
| Electrical & Communication | 35.1 | 34.1 | 42.8 | 25.5% |
| Engineering Educ. Centers | 75.4 | 81.0 | 92.7 | 14.4% |
| Indust. Innovation Interface | 24.2 | 24.7 | 36.9 | 49.4% |
| Mech. & Structural Systems | 25.2 | 23.6 | 30.1 | 27.7% |
| Total ENG | 258.1 | 261.1 | 323.1 | 23.7% |
| Biological Sciences (BIO) | | | | |
| Molecular & Cellular Biosci. | 83.1 | 82.1 | 94.1 | 14.6% |
| Integrative Bio. & Neurosci. | 77.2 | 76.4 | 88.0 | 15.1% |
| Environmental Biology | 72.6 | 71.7 | 83.1 | 15.9% |
| Instrumentation & Resources | 41.4 | 41.1 | 46.7 | 13.6% |
| Total BIO | 274.4 | 271.3 | 311.9 | 15.0% |
| Geosciences (GEO) | | | | |
| Atmospheric Sciences | 126.5 | 126.3 | 149.1 | 18.0% |
| Earth Sciences | 75.9 | 75.8 | 89.7 | 18.3% |
| Ocean Sciences | 177.5 | 177.7 | 209.8 | 18.1% |
| Science and Tech. Centers | 0.9 | 0.0 | 0.0 | — |
| Total GEO | 380.8 | 379.8 | 448.5 | 18.1% |
| Computer Information Science and Engineering (CISE) | | | | |
| Computer & Computation | 34.8 | 34.8 | 46.1 | 32.4% |
| Information, Robotics and Intelligent Systems | 26.9 | 27.0 | 40.6 | 50.7% |
| Microelectronic Information Processing Systems | 21.4 | 21.5 | 32.8 | 52.8% |
| Adv. Scientific Computing | 69.4 | 69.5 | 91.3 | 31.3% |
| Networking & Communication Research & Infrastructure | 35.4 | 40.0 | 54.9 | 37.5% |
| Cross-Disciplinary Activities | 22.4 | 22.5 | 30.3 | 34.6% |
| Total CISE | 210.4 | 215.2 | 296.0 | 37.5% |
| Social, Behavioral and Economic Sciences (SBE) | | | | |
| Social, Behavioral, & Econ. | 66.0 | 65.4 | 75.3 | 15.1% |
| Int'l Coop. Sci. Activities | 13.1 | 12.4 | 18.9 | 52.5% |
| Science Resources Studies | 6.9 | 11.7 | 12.7 | 8.6% |
| Total SBE | 86.0 | 89.5 | 106.9 | 19.4% |

# TABLE II-7., continued

**Table II-7 (continued).** R&D in the National Science Foundation (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| EPSCoR 1/ | 18.0 | — | — | — |
| Arctic Research Program /2 | 21.1 | 22.1 | — | — |
| Adjustments | 0.9 | — | — | |
| TOTAL R&RA | 1,872.0 | 1,859.0 | 2,204.8 | 18.6% |
| Education and Human Resources (EHR) | | | | |
| Systematic Reform 1/ | 44.5 | 85.7 | 103.0 | 20.2% |
| Elementary & Secondary | 198.1 | 188.5 | 198.0 | 5.0% |
| Undergraduate Education | 60.7 | 61.7 | 74.8 | 21.2% |
| Grad. Educ. & Research Dev. | 55.6 | 62.5 | 66.5 | 6.4% |
| Human Resource Development | 46.3 | 48.9 | 65.9 | 34.8% |
| Rsrch, Eval, & Dissemination | 36.3 | 40.3 | 48.0 | 19.1% |
| Adjustment | 23.6 | — | — | — |
| TOTAL EHR | 465.0 | 487.5 | 556.1 | 14.1% |
| Acad. Rsrch. Facil. & Instrument. | 33.0 | 50.0 | 55.0 | 10.0% |
| Critical Technologies Institute | 0.0 | 1.0 | 1.0 | 0.0% |
| US Polar Research 2/ 3/ | 118.0 | 158.0 | 163.1 | 3.2% |
| Antarctic Logistical Support 3/ | 75.0 | 63.4 | 65.1 | 2.7% |
| Less Antarctic BA in Other Approp. 3/ | -105.0 | — | — | — |
| Salaries and Expenses | 111.2 | 111.0 | 125.8 | 13.3% |
| Headquarters Relocation | 0.0 | 0.0 | 5.2 | — |
| Inspector General | 3.5 | 3.7 | 4.1 | 11.2% |
| TOTAL NSF BA | 2,572.7 | 2,733.5 | 3,180.2 | 16.3% |
| Deduct Non-R&D Activities | | | | |
| R&RA | 7.3 | 13.0 | 13.1 | 0.8% |
| EHR416.7 | 402.8 | 461.2 | 14.5% | |
| Critical Technologies Inst. | 0.0 | 1.0 | 1.0 | 0.0% |
| US Polar Research /2 | 62.2 | 193.5 | 167.5 | -13.4% |
| Salaries and Expenses | 111.2 | 111.0 | 125.8 | 13.3% |
| Headquarters Relocation | 0.0 | 0.0 | 5.2 | — |
| Inspector General | 3.5 | 3.7 | 4.1 | 11.2% |
| TOTAL NSF R&D | 1,971.7 | 2,008.6 | 2,402.3 | 19.6% |
| Conduct of R&D | 1,870.2 | 1,870.7 | 2,217.0 | 18.5% |
| R&D Facilities | 101.6 | 137.9 | 185.4 | 34.4% |

Source: Agency budget justification and Quantitative Data Tables.

1/The Experimental Programs to Stimulate Competitive Research (EPSCoR) was transferred to the Education and Human Resources Directorate in FY 1993.

2/NSF has proposed a new "U.S. Polar Research Program" account which would include Arctic Research currently funded under R&RA and programs in the Antarctic Research Activities.

3/In FY 1992, funding for Antarctic Research Activities and Logistical Support was derived in part by appropriations to other agencies and accounts.

# TABLE II-8., HHS R&D

**Table II-8.** R&D in the Department of Health and Human Services (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Health** | | | | |
| NIH 1/ | 9,624.3 | 9,890.2 | 10,207.9 | 3.2% |
| Centers for Disease Control | 146.9 | 149.5 | 183.1 | 22.4% |
| Food & Drug Administration | 135.7 | 139.1 | 151.2 | 8.7% |
| Asst. Secretary for Health | 6.9 | 22.7 | 7.0 | -69.2% |
| Health Care Financing Admin. | 76.4 | 68.7 | 52.2 | -24.0% |
| Health Resources and Services Administration | 10.2 | 10.9 | 11.3 | 3.7% |
| Indian Health Services | 0.7 | 0.7 | 0.8 | 3.6% |
| Health Care Policy & Rsrch. | 106.3 | 114.8 | 144.8 | 26.1% |
| Total Health R&D | 10,107.4 | 10,396.6 | 10,758.3 | 3.5% |
| **Human Services** | | | | |
| Administration for Children and Families | 39.2 | 21.1 | 18.5 | -12.0% |
| Administration on Aging | 0.0 | 19.5 | 20.0 | 2.6% |
| Social Security Admin. | 28.1 | 40.1 | 27.1 | -32.4% |
| Office of the Secretary | 5.0 | 8.0 | 8.3 | 3.8% |
| Total Human Services | 72.3 | 88.7 | 73.9 | -16.6% |
| TOTAL HHS R&D | 10,179.7 | 10,485.3 | 10,832.2 | 3.3% |
| Conduct of R&D | 10,058.8 | 10,369.0 | 10,703.5 | 3.2% |
| R&D Facilities | 120.8 | 116.3 | 128.7 | 10.7% |

Source: OMB data for R&D for FY 1994 and agency budget justification.
1/Reflects restructuring of National Institutes of Health (NIH) and the transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) under P.L. 102-321.

# TABLE II-9., NIH R&D BY INSTITUTE

**Table II-9.** R&D in the National Institutes of Health 1/ (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Cancer | 1,947.6 | 1,978.3 | 2,142.1 | 8.3% |
| Heart, Lung and Blood | 1,190.1 | 1,214.7 | 1,198.4 | -1.3% |
| Dental Research | 158.9 | 161.1 | 163.0 | 1.2% |
| Diabetes, Digestive and Kidney Disorders | 662.1 | 680.7 | 677.1 | -0.5% |
| Neurological Disorders & Stroke | 580.8 | 599.5 | 590.1 | -1.6% |
| Allergy & Infectious Diseases | 960.1 | 988.4 | 1,065.6 | 7.8% |
| General Medical Sciences | 814.7 | 832.2 | 833.1 | 0.1% |
| Child Health & Human Dev. | 518.8 | 527.8 | 542.4 | 2.8% |
| Eye | 270.0 | 275.9 | 272.2 | -1.3% |
| Environmental Health Sciences | 251.6 | 251.2 | 261.3 | 4.0% |
| Aging | 382.9 | 399.5 | 394.2 | -1.3% |
| Arthritis and Musculoskeletal and Skin Diseases | 203.5 | 212.2 | 210.4 | -0.9% |
| Deafness & Communication | 148.8 | 154.8 | 153.1 | -1.1% |
| Research Resources | 314.2 | 312.7 | 327.9 | 4.9% |
| Nursing Research | 44.9 | 48.5 | 49.0 | 1.0% |
| Human Genome | 104.8 | 106.1 | 134.5 | 26.8% |
| Fogarty International Center | 19.6 | 19.7 | 20.0 | 1.4% |
| National Library of Medicine | 102.7 | 103.6 | 133.3 | 28.7% |
| Office of Director | 144.2 | 190.3 | 234.9 | 23.4% |
| Buildings and Facilities | 108.8 | 108.7 | 108.7 | 0.0% |
| Mental Health | 560.5 | 583.1 | 576.0 | -1.2% |
| Drug Abuse | 399.2 | 404.2 | 407.1 | 0.7% |
| Alcoholism and Alcohol Abuse | 171.7 | 176.4 | 173.6 | -1.6% |
| Total NIH Budget | 10,060.4 | 10,329.8 | 10,668.0 | 3.3% |
| Estimated Research Training | -348.0 | -349.0 | -355.0 | 1.7% |
| Other Non-R&D | -88.1 | -90.6 | -105.1 | 16.0% |
| TOTAL NIH R&D | 9,624.3 | 9,890.2 | 10,207.9 | 3.2% |
| Conduct of R&D | 9,503.4 | 9,773.8 | 10,079.2 | 3.1% |
| R&D Facilities | 120.8 | 116.3 | 128.7 | 10.7% |

Source: OMB data for R&D for FY 1994 and agency budget justification.
1/Reflects restructuring of NIH and the transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) under P.L. 102-321.

# TABLE II-10. NIH R&D BY FUNDING MECHANISM

**Table II-10.** R&D in the National Institutes of Health by Funding Mechanism (budget authority in millions of dollars) 1/

| Funding Mechanisms | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Research Grants | | | | |
| Research projects | 5,480.7 | 5,665.1 | 5,685.5 | 0.4% |
| Noncompeting | (3,912.3) | (4,341.6) | (4,297.3) | -1.0% |
| Admin. Supplementals | (56.4) | (27.3) | (28.3) | 3.8% |
| Competing | (1,512.0) | (1,296.2) | (1,359.9) | 4.9% |
| Research Centers | 896.9 | 911.9 | 949.8 | 4.1% |
| Other Research Grants | 535.5 | 525.3 | 548.9 | 4.5% |
| Total Grants | 6,913.1 | 7,102.3 | 7,184.2 | 1.2% |
| R&D Contracts | 706.4 | 698.9 | 777.8 | 11.3% |
| Intramural Research | 1,132.2 | 1,167.2 | 1,218.0 | 4.4% |
| Research Mgmt. & Support | 485.3 | 496.9 | 498.1 | 0.3% |
| Cancer Control | 107.6 | 105.0 | 137.9 | 31.3% |
| Training | 348.0 | 349.2 | 354.9 | 1.6% |
| Construction | 12.0 | 7.6 | 20.0 | 163.1% |
| Library of Medicine | 102.7 | 103.6 | 133.3 | 28.7% |
| Office of the Director | 144.2 | 190.3 | 234.9 | 23.4% |
| Buildings and Facilities | 108.8 | 108.7 | 108.7 | 0.0% |
| TOTAL NIH Budget | 10,060.4 | 10,329.8 | 10,668.0 | 3.3% |

Source: Agency budget justification.

1/Includes all NIH support, including non-R&D activities such as research training. Also reflects transfer of the research components of the three institutes of the former Alcohol, Drug Abuse, and Mental Health Administration under P.L. 102-321.

# TABLE II-11. DOE R&D

**Table II-11.** R&D in the Department of Energy (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| DOE Appropriations Containing R&D | | | | |
| 1. Energy Supply R&D | 2,107.3 | 2,056.0 | 1,994.8 | -3.0% |
| 2. Fossil Energy R&D | 355.5 | 332.2 | 322.2 | -3.0% |
| 3. Energy Conservation | 230.0 | 281.2 | 367.8 | 30.8% |
| 4. General Science 1/ | 1,441.4 | 1,398.5 | 1,577.7 | 12.8% |
| 5. Atomic Energy Defense | 3,452.3 | 3,254.1 | 3,016.0 | -7.3% |
| 6. Uranium Enrichment | 161.7 | 69.0 | 0.0 | -100.0% |
| 7. Clean Coal Technology | 385.1 | 0.0 | 250.0 | — |
| 8. Bonneville Power Admin. 2/ | (19.8) | (20.0) | (21.0) | 5.0% |
| TOTAL DOE R&D | 8,133.4 | 7,391.0 | 7,528.4 | 1.9% |
| 1. Energy Supply R&D | | | | |
| Solar Energy | | | | |
| Solar Bldg. Energy Systems | 2.0 | 2.9 | 5.0 | 71.6% |
| Photovoltaic Energy Systems | 60.0 | 63.7 | 78.0 | 22.5% |
| Solar Thermal Energy Systems | 28.8 | 26.3 | 32.7 | 24.5% |
| Biofuels Energy Systems | 39.0 | 47.1 | 58.2 | 23.4% |
| Wind Energy Systems | 21.3 | 23.4 | 30.4 | 29.9% |
| Ocean Energy Systems | 2.0 | 0.9 | 0.0 | -100.0% |
| Int'l Solar Energy Program | 2.0 | 1.9 | 5.8 | 195.8% |
| Solar Technology Transfer | 1.0 | 1.9 | 16.4 | 743.4% |
| Nat'l Renewable Energy Lab. | 11.5 | 6.6 | 5.9 | -9.5% |
| Support & Resource Assess. | 2.1 | 2.1 | 7.8 | 273.0% |
| Total Solar Energy | 169.6 | 176.9 | 240.2 | 35.8% |
| Geothermal | 25.9 | 21.8 | 23.0 | 5.3% |
| Hydropower | 0.9 | 1.0 | 0.9 | -1.5% |
| Nuclear Energy | | | | |
| Light Water Reactors | 61.9 | 58.7 | 57.8 | -1.6% |
| Advanced Reactor R&D | 60.0 | 60.0 | 15.0 | -75.0% |
| Advanced Radio Isotope Power | 51.9 | 54.5 | 48.1 | -11.7% |
| Space/Reactor Power | 40.0 | 30.0 | 5.0 | -83.3% |
| Space Exploration Initiative | 4.9 | 0.0 | 0.0 | — |
| Facilities | 96.6 | 94.1 | 6.9 | -92.7% |
| TRA Hot Cells | 0.0 | 0.0 | 1.4 | — |
| Use of Prior Balances | -2.7 | -46.1 | -17.0 | -63.2% |
| Total Nuclear Energy | 312.7 | 251.2 | 117.2 | -53.3% |
| Electric Energy & Storage | 36.5 | 40.3 | 48.7 | 21.0% |
| Bio. & Environmental Research | 346.3 | 336.3 | 338.1 | 0.5% |
| Occupational Health | 49.4 | 51.2 | 50.8 | -0.8% |
| Magnetic Fusion | 324.7 | 322.4 | 338.4 | 5.0% |
| Basic Energy Sciences (BES) | | | | |
| Materials Sciences | 253.5 | 271.2 | 277.0 | 2.1% |
| Chemical Sciences | 156.5 | 162.4 | 169.0 | 4.1% |
| Applied Math. Sciences | 80.5 | 83.2 | 106.2 | 27.6% |
| Engineering & Geosciences | 35.4 | 36.2 | 37.9 | 4.8% |
| Advanced Energy Projects | 54.7 | 10.9 | 11.4 | 4.7% |
| Energy Biosciences | 24.4 | 25.3 | 26.7 | 5.7% |
| Equipment & Construction | 148.0 | 248.9 | 164.4 | -33.9% |
| Total BES | 752.9 | 838.0 | 792.6 | -5.4% |

# TABLE II-11., continued

**Table II-11 (continued).** R&D in the Department of Energy (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Advanced Neutron Source 3/ | [24.1] | [21.4] | 39.0 | [82.2%] |
| Energy Research Analyses | 4.0 | 3.9 | 4.0 | 2.7% |
| Technology Transfer | 10.0 | 9.8 | 39.4 | 300.7% |
| Univ. & Science Education 4/ | 54.2 | 55.6 | 58.0 | 4.3% |
| BA Adj. Univ. & Science Ed. 4/ | -22.4 | -52.4 | -58.0 | 10.7% |
| SBIR 5/ | 42.6 | 0.0 | 0.0 | — |
| Undistributed Adjustment | — | — | -37.4 | — |
| TOTAL Supply R&D | 2,107.3 | 2,056.0 | 1,994.8 | -3.0% |
| 2. Fossil Energy R&D | | | | |
| Coal | 225.6 | 188.7 | 141.3 | -25.1% |
| Petroleum | 56.5 | 62.4 | 80.9 | 29.6% |
| Gas | 63.2 | 80.5 | 101.0 | 25.3% |
| Cooperative R&D | 10.7 | 9.9 | 4.8 | -51.2% |
| Facilities | 10.4 | 4.5 | 2.8 | -39.0% |
| Adjustments | -10.9 | -13.8 | -8.6 | -37.8% |
| TOTAL Fossil Energy | 355.5 | 332.2 | 322.2 | -3.0% |
| 3. Energy Conservation | | | | |
| Building Technologies | 37.5 | 42.1 | 64.5 | 53.3% |
| Industrial Technologies | 85.4 | 102.4 | 122.4 | 19.5% |
| Transportation Technologies | 102.4 | 131.8 | 174.1 | 32.1% |
| Utility Technologies | 4.7 | 5.0 | 6.8 | 37.1% |
| TOTAL Conservation | 230.0 | 281.2 | 367.8 | 30.8% |
| 4. General Science and Research | | | | |
| High Energy Physics | 618.4 | 594.9 | 627.8 | 5.5% |
| Nuclear Physics, w/LAMPF 1/ | 351.4 | 364.6 | 322.3 | -11.6% |
| BA for LAMPF 1/ | 0.0 | -64.5 | 0.0 | -100.0% |
| SSC | 471.6 | 503.5 | 627.6 | 24.6% |
| TOTAL General | 1,441.4 | 1,398.5 | 1,577.7 | 12.8% |
| 5. Atomic Energy Defense Activities | | | | |
| Naval Reactors | 679.2 | 712.8 | 679.4 | -4.7% |
| Weapons RD&T 1/ | 1,923.7 | 1,955.4 | 1,784.5 | -8.7% |
| Weapons R&D, LAMPF 1/ | — | 64.5 | — | — |
| Verification and Control | 83.0 | 114.3 | 144.4 | 26.3% |
| Nuclear Safeguards & Security | 28.4 | 28.0 | 27.6 | -1.4% |
| Materials Production | 59.2 | 59.5 | 55.3 | -7.1% |
| New Production Reactor | 444.2 | 0.0 | 0.0 | — |
| Environmental Restoration | 206.7 | 261.8 | 261.4 | -0.2% |
| Office of Intelligence | 5.5 | 5.4 | 5.4 | 0.0% |
| BA for Univ. & Sci. Ed. 4/ | 22.4 | 52.4 | 58.0 | 10.7% |
| TOTAL Atomic Defense | 3,452.3 | 3,254.1 | 3,016.0 | -7.3% |

## TABLE II-11., continued

**Table II-11 (continued).** R&D in the Department of Energy (budget authority in millions of dollars)

| | | | | |
|---|---|---|---|---|
| 6. Uranium Enrichment | 161.7 | 69.0 | 0.0 | -100.0% |
| 7. Clean Coal Technology | 385.1 | 0.0 | 250.0 | — |
| 8. Bonneville Power Admin. 2/ | (19.8) | (20.0) | (21.0) | 5.0% |
| TOTAL DOE R&D | 8,133.4 | 7,391.0 | 7,528.4 | 1.9% |
| Conduct of R&D | 6,471.2 | 5,997.6 | 6,098.5 | 1.7% |
| R&D Facilities | 1,662.2 | 1,393.4 | 1,430.0 | 2.6% |

Source: Agency budget justification and supporting documents. Includes conduct of R&D and facilities.

1/In FY 1993, the Los Alamos Meson Physics Facility (LAMPF) was funded in the appropriation for Weapons R&D rather than General Science. For comparability, the funding is included in the total shown for nuclear physics, but the budget authority is deducted from General Science and counted under the Weapons R&D (under Atomic Energy Defense Activities) appropriation.

2/Represents obligational authority financed by BPA ratepayers.

3/Formerly funded under Basic Energy Sciences.

4/Total funding for University and Science Education is shown under Energy Supply, but some of the budget authority is provided in the Atomic Energy Defense Activities appropriation.

5/Small Business Innovation Research.

## TABLE II-12. NASA R&D

**Table II-12.** R&D in the National Aeronautics and Space Administration (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Research & Development Appropriation** | | | | |
| Space Station & Technology Investments | | | | |
| Space Station | 2,002.7 | 2,122.5 | TBD | — |
| Technology | — | — | TBD | — |
| Total Station & Tech. | 2,002.7 | 2,122.5 | 2,300.0 | 8.4% |
| Space Transportation | | | | |
| Capability Development | 739.7 | 649.2 | 649.2 | 0.0% |
| Physics and Astronomy 1/ | 982.9 | 1,034.9 | 1,074.7 | 3.8% |
| Planetary Exploration | 534.2 | 473.6 | 557.2 | 17.6% |
| Life Sci. & Microgravity 1/ | 356.5 | 407.5 | 351.0 | -13.9% |
| Mission to Planet Earth | 838.8 | 949.0 | 1,074.9 | 13.3% |
| Commercial Programs 1/ | 148.9 | 165.4 | 172.0 | 4.0% |
| Space R&T | 309.2 | 272.7 | 298.2 | 9.3% |
| Aeronautics R&T | 788.2 | 860.9 | 1,020.7 | 18.6% |
| Transatmospheric R&T | 4.1 | 0.0 | 80.0 | — |
| Safety, Reliability & Quality | 33.6 | 32.7 | 35.3 | 7.9% |
| Tracking & Adv. Data Sys. | 22.0 | 23.2 | 24.6 | 6.0% |
| Academic Programs | 66.8 | 92.9 | 74.5 | -19.8% |
| TOTAL R&D Approp. | 6,827.6 | 7,084.6 | 7,712.3 | 8.9% |
| Other Appropriations 2/ | 1,716.6 | 1,762.6 | 1,834.0 | 4.1% |
| TOTAL NASA R&D | 8,544.2 | 8,847.1 | 9,546.3 | 7.9% |
| Conduct of R&D | (7,712.0) | (8,002.6) | (8,666[illegible]) | 8.3% |
| R&D Facilities | (832.1) | (844.6) | (879.9) | 4.2% |
| NASA Operations 3/ | 5,771.9 | 5,469.0 | 5,718.4 | 4.6% |
| TOTAL NASA Budget | 14,316.1 | 14,316.1 | 15,264.7 | 6.6% |
| **Detail of R&D Appropriation** | | | | |
| Space Station and Technology Investments | | | | |
| Space Station | 2,002.7 | 2,122.5 | TBD | — |
| Technology | — | — | TBD | — |
| Total Station & Tech. | 2,002.7 | 2,122.5 | 2,300.0 | 8.4% |

## TABLE II-12., continued

**Table II-12 (continued).** R&D in the National Aeronautics and Space Administration (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Space Transportation | | | | |
| Capability Development | | | | |
| Spacelab | 99.2 | 114.5 | 139.9 | 22.2% |
| Upper Stages 4/ | 31.1 | [40.0] | [39.5] | — |
| Engineering & Technical Base | 210.8 | 214.2 | 203.4 | -5.0% |
| Payload Ops. & Support Equip. | 130.1 | 131.5 | 95.4 | -27.5% |
| Advanced Programs 4/ | 44.8 | 32.9 | 60.7 | 84.5% |
| New Launch System | 28.0 | 10.0 | 0.0 | -100.0% |
| Tethered Satellite System | 16.4 | 3.4 | 0.0 | -100.0% |
| Research Operations Support | 179.3 | 142.8 | 149.8 | 4.9% |
| Total Space Transportation | 739.7 | 649.2 | 649.2 | 0.0% |
| Physics and Astronomy | | | | |
| Gravity Probe-B Development | — | 1.9 | 40.0 | 2005.3% |
| Global Geospace Science | 75.3 | 72.6 | 13.3 | -81.7% |
| Advanced X-Ray Astrophysics Facility (AFAX) | 150.7 | 168.3 | 260.3 | 54.6% |
| Payload & Instrument Dev. | 118.3 | 99.3 | 53.4 | -46.2% |
| Explorer Development | 109.1 | 115.8 | 123.3 | 6.4% |
| Mission Ops. & Data Anal. | 375.2 | 415.4 | 416.2 | 0.2% |
| Research and Analysis | 69.9 | 71.6 | 72.2 | 0.9% |
| Suborbital Program | 60.1 | 64.8 | 69.5 | 7.2% |
| Information Systems 5/ | 24.2 | 25.0 | 26.5 | 5.8% |
| Total Physics/Astronomy | 982.9 | 1,034.9 | 1,074.7 | 3.8% |
| Planetary Exploration | | | | |
| Mars Observer | 85.0 | — | — | — |
| Mars Balloon Relay Experiment | 1.2 | — | — | — |
| Mars '94 | — | 3.5 | 3.5 | 0.0% |
| Cassini Development | 210.7 | 205.0 | 266.6 | 30.1% |
| Mission Ops. and Data Anal. | 160.7 | 163.5 | 160.7 | -1.7% |
| Research and Analysis | 76.6 | 101.7 | 126.4 | 24.3% |
| Total Planetary | 534.2 | 473.6 | 557.2 | 17.6% |

# TABLE II-12., continued

**Table II-12 (continued).** R&D in the National Aeronautics and Space Administration (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93-94 |
|---|---|---|---|---|
| Life and Microgravity Sciences & Applications (LSA, MSA) | | | | |
| Research and Analysis: LSA | 50.7 | 53.9 | 49.2 | -8.8% |
| Flight Experiments: LSA | 94.7 | 81.1 | 94.7 | 16.8% |
| Centrifuge | [7.7] | 5.5 | 0.0 | -100.0% |
| Search for Extraterrestrial Intelligence | 12.3 | 0.0 | 0.0 | — |
| Research & Analysis: MSA 6/ | 16.6 | 17.9 | 18.4 | 3.0% |
| Flight Experiments: MSA 6/ | 104.2 | 155.1 | 71.0 | -54.2% |
| Shuttle/Spacelab Payload Mission Management and Integration 7/ | 78.0 | 94.0 | 117.7 | 25.2% |
| Total LSA, MSA | 356.5 | 407.5 | 351.0 | -13.9% |
| Mission to Planet Earth | | | | |
| Earth Observing System | 176.4 | 263.8 | 322.7 | 22.3% |
| EOS Data Info. System | 77.7 | 130.7 | 182.7 | 39.8% |
| Earth Probes/Scatterometer | 77.8 | 99.4 | 97.3 | -2.1% |
| Ocean Topography Experiment | 65.0 | 0.0 | 0.0 | — |
| Payload Instrument Dev. | 37.9 | 35.5 | 22.9 | -35.4% |
| Mission Ops. & Data Anal. | 100.6 | 147.6 | 160.8 | 9.0% |
| Interdisciplinary Research | 2.3 | 4.5 | 5.0 | 12.3% |
| Modeling and Data Analysis | 45.8 | 42.6 | 45.0 | 5.7% |
| Process Studies | 121.5 | 119.3 | 131.5 | 10.3% |
| Airborne Sci. & Applications | 20.3 | 20.7 | 25.2 | 21.7% |
| Advanced Communications Technology Satallite 8/ | 18.7 | 4.0 | 3.0 | -24.4% |
| Information Systems 5/ | 10.8 | 11.2 | 11.8 | 5.8% |
| Research Operations Support | 83.9 | 70.1 | 67.0 | -4.4% |
| Total Mission to Earth | 838.8 | 949.0 | 1,074.9 | 13.3% |
| Commercial Programs | | | | |
| Technology Utilization | 32.5 | 29.5 | 26.9 | -8.8% |
| Commercial Use of Space 9/ | 116.4 | 135.9 | 145.1 | 6.8% |
| Total Commercial | 148.9 | 165.4 | 172.0 | 4.0% |
| Aeronautics Research and Technology | | | | |
| Research & Technology Base | 343.3 | 436.5 | 448.3 | 2.7% |
| Systems Tech. Programs | 212.1 | 275.6 | 428.9 | 55.6% |
| Research Operations Support | 232.8 | 148.8 | 143.5 | -3.6% |
| Total Aeronautics R&T | 788.2 | 860.9 | 1,020.7 | 18.6% |

## TABLE II-12., continued

**Table II-12 (continued).** R&D in the National Aeronautics and Space Administration (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Space Research and Technology | | | | |
| Research & Technology Base | 140.9 | 158.1 | 160.8 | 1.7% |
| In-space Experiments | 15.1 | — | — | — |
| Civilian Space Technology Initiative | 82.9 | 114.6 | 137.4 | 19.9% |
| Exploration Technology | 28.9 | — | — | — |
| Space Automation and Telerobotics | 37.9 | — | — | — |
| Exploration Mission Studies | 3.5 | — | — | — |
| Total Space R&T | 309.2 | 272.7 | 298.2 | 9.3% |
| Transatmospheric R&T | 4.1 | 0.0 | 80.0 | — |
| Safety, Reliability and Quality Assurance | 33.6 | 32.7 | 35.3 | 7.9% |
| Tracking & Adv. Data Systems | 22.0 | 23.2 | 24.6 | 6.0% |
| Academic Programs | | | | |
| Educational Affairs | 29.8 | 56.8 | 36.8 | -35.2% |
| Space Grant College and Fellowships | 15.0 | 13.4 | 14.5 | 8.2% |
| Minority University Research | 22.0 | 22.7 | 23.2 | 2.2% |
| Total Academic Programs | 66.8 | 92.9 | 74.5 | -19.8% |

Source: OMB data for R&D for FY 1994 and agency budget justification.

1/FY 1992 and 1993 figures have been made comparable to the new account structure being used by NASA in FY 1994.

2/ R&D funding in "Research and Program Management" and "Construction of Facilities" accounts.

3/ Includes Space Flight, Control and Data Communications funding and the non-R&D portion of the RPM account.

4/The FY 1992 has been adjusted to exclude $10.1 million, which is shown in the "advanced programs" line to be comparable with the FY 1993-94 structure. The remaining FY 1993-94 activity has been classified as non-R&D.

5/Formerly under "other space applications." Amounts shown for FY 1992 and 1993 have been prorated between "Physics and Astronomy" and "Mission to Planet Earth" based on the FY 1994 allocation.

6/Formerly materials processing under "other space applications."

7/Formerly under "physics and astronomy."

8/Formerly under "other space applications."

9/Includes "search and rescue," formerly under "other space applications."

# TABLE II-13. DEPARTMENT OF AGRICULTURE R&D

**Table II-13.** R&D in the Department of Agriculture (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Agricultural Research Service (ARS) | | | | |
| Programs | 670.6 | 668.5 | 683.4 | 2.2% |
| Buildings & Facilities | 65.6 | 34.5 | 24.6 | -28.8% |
| Total ARS | 736.2 | 703.0 | 708.0 | 0.7% |
| Cooperative State Research Service (CSRS) | | | | |
| Programs | 418.4 | 418.6 | 416.5 | -0.5% |
| National Research Initiative | 97.5 | 97.5 | 130.2 | 33.5% |
| Ag. Experiment Stations | 168.8 | 168.8 | 173.5 | 2.8% |
| Cooperative Forestry | 18.5 | 18.5 | 28.0 | 51.4% |
| 1890 Colleges & Tuskegee | 27.4 | 27.4 | 28.2 | 2.9% |
| 1890 Capacity Building | 3.8 | 3.7 | 5.6 | 48.4% |
| Special Research Grants | 73.1 | 73.4 | 34.4 | -53.1% |
| Animal Health & Disease | 5.6 | 5.6 | 0.0 | -100.0% |
| Administration | 10.5 | 10.5 | 2.1 | -80.0% |
| Aquaculture Rsrch. Centers | 4.0 | 4.0 | 4.1 | 2.5% |
| Alternative Crops | 1.2 | 1.2 | 3.0 | 150.0% |
| Sustainable Agriculture | 6.7 | 6.7 | 6.9 | 3.0% |
| Critical Materials | 0.4 | 0.4 | 0.0 | -100.0% |
| State Ag. Weather Info. Sys. | 0.4 | 0.4 | 0.0 | -100.0% |
| Rangeland Research Grants | 0.5 | 0.5 | 0.5 | 0.0% |
| Buildings & Facilities | 74.8 | 52.1 | 0.0 | -100.0% |
| Total CSRS | 493.1 | 470.7 | 416.5 | -11.5% |
| Forest Service | 184.1 | 186.3 | 200.6 | 7.7% |
| Economics Research Service | 58.9 | 58.9 | 51.5 | -12.7% |
| Agricultural Cooperative Service | 3.5 | 3.5 | 3.6 | 1.6% |
| Agricultural Marketing Service | 4.8 | 4.9 | 4.9 | 0.7% |
| Int'l Cooperation & Dev. | 1.5 | 1.5 | 1.6 | 6.7% |
| Human Nutrition Information | 10.8 | 10.8 | 10.9 | 0.9% |
| National Agricultural Statistics | 3.6 | 3.6 | 3.7 | 2.1% |
| Animal and Plant Inspection | 16.7 | 16.8 | 16.7 | -0.6% |
| Federal Grain Inspection | 1.5 | 1.2 | 1.0 | -16.0% |
| Office of the Secretary | 4.5 | 7.3 | 20.0 | 175.9% |
| TOTAL USDA R&D | 1,519.2 | 1,468.5 | 1,438.8 | -2.0% |
| Conduct of R&D | 1,334.9 | 1,336.2 | 1,364.9 | 2.1% |
| R&D Facilities | 184.4 | 132.3 | 74.0 | -44.1% |

Source: OMB data for R&D for FY 1994 and agency budget justification.

# TABLE II-14. R&D IN THE DEPARTMENT OF COMMERCE

**Table II-14.** R&D in the Department of Commerce (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| National Oceanic and Atmospheric Administration | 379.1 | 395.3 | 424.3 | 7.3% |
| National Institute of Standards and Technology | | | | |
| Scientific & Technical Rsrch. | 151.4 | 162.3 | 201.1 | 23.9% |
| Adv. Technology Program | 46.9 | 64.0 | 187.8 | 193.3% |
| Construction | 0.0 | 105.0 | 61.7 | -41.3% |
| Total NIST R&D | 198.3 | 331.3 | 450.6 | 36.0% |
| Bureau of the Census | 5.3 | 5.1 | 5.2 | 2.7% |
| Economic Development Admin. | 0.5 | 0.0 | 0.5 | — |
| TOTAL Commerce R&D | 583.3 | 731.7 | 880.6 | 20.3% |
| Conduct of R&D | 544.9 | 589.5 | 783.1 | 32.8% |
| R&D Facilities | 38.5 | 142.2 | 97.5 | -31.4% |

Source: OMB data for R&D for FY 1994 and agency budget justification.

# TABLE II-15. R&D IN THE DEPARTMENT OF TRANSPORTATION

**Table II-15.** R&D in the Department of Transportation (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Federal Aviation Administration | 270.1 | 281.2 | 297.2 | 5.7% |
| Federal Highway Administration | 235.8 | 227.1 | 267.8 | 17.9% |
| National Highway Traffic Safety Administration | 25.8 | 32.0 | 30.1 | -5.9% |
| Coast Guard | 29.2 | 27.8 | 25.8 | -7.2% |
| Federal Railroad Administration | 22.3 | 32.5 | 63.2 | 94.6% |
| Office of the Secretary | 4.6 | 4.4 | 5.2 | 17.8% |
| Research and Special Programs Administration | 2.5 | 2.4 | 2.9 | 22.8% |
| Federal Transit Administration | 29.1 | 18.8 | 16.3 | -12.9% |
| Maritime Administration | 1.8 | 1.7 | 7.3 | 321.2% |
| TOTAL DOT R&D | 621.1 | 627.8 | 715.8 | 14.0% |
| Conduct of R&D | 579.8 | 588.2 | 675.6 | 14.9% |
| R&D Facilities | 41.3 | 39.5 | 40.2 | 1.7% |

Source: OMB data for R&D for FY 1994 and agency budget justification.

## TABLE II-16. R&D IN THE DEPARTMENT OF THE INTERIOR

**Table II-16** R&D in the Department of the Interior (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | %Change FY 93–94 |
|---|---|---|---|---|
| U.S. Geological Survey | 365.7 | 358.8 | 378.2 | 5.4% |
| Bureau of Mines | 106.2 | 109.6 | 89.7 | -18.2% |
| Fish and Wildlife Service | 111.3 | 92.2 | 112.0 | 21.4% |
| National Park Service | 29.0 | 31.0 | 39.5 | 27.4% |
| Bureau of Reclamation | 13.6 | 6.7 | 7.0 | 4.5% |
| Bureau of Land Management | 9.7 | 8.0 | 8.5 | 6.3% |
| Office of Surface Mining Reclamation & Enforcement | 1.7 | 1.9 | 1.9 | 0.0% |
| Minerals Management Service | 4.8 | 6.0 | 6.0 | 0.1% |
| Office of the Secretary | 0.9 | 0.9 | 0.9 | 0.0% |
| TOTAL Interior R&D | 642.9 | 615.1 | 643.7 | 4.6% |
| Conduct of R&D | 611.5 | 600.0 | 620.0 | 3.3% |
| R&D Facilities | 31.4 | 15.2 | 23.7 | 56.5% |

**Note: Est. R&D funding to be transferred to a "National Biological Survey"**

| | Est. R&D FY 1994 | Transfers as % Agency R&D |
|---|---|---|
| **Fish and Wildlife Service** | 109.1 | 97.4% |
| **National Park Service** | 31.4 | 79.5% |
| **Bureau of Land Management** | 8.2 | 96.6% |
| **Bureau of Reclamation** | 1.7 | 24.5% |
| **U.S. Geological Survey** | 0.6 | 0.2% |
| **Office of Surface Mining Reclamation & Enforcement** | 0.4 | 21.1% |
| **Bureau of Mines** | 0.4 | 0.4% |
| **Total Est. R&D in the NBS** | 151.9 | 23.6% |

Source: OMB data for R&D for FY 1994 and agency budget justifications and R&D crosscuts.

# TABLE II-17. EPA R&D

**Table II-17.** R&D in the Environmental Protection Agency (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| **Operating Programs** | | | | |
| Multimedia | 152.1 | 163.8 | 217.6 | 32.8% |
| Air Quality | 85.2 | 90.3 | 87.4 | -3.1% |
| Acid Deposition | 13.5 | 15.7 | 10.9 | -30.6% |
| Global Change | 24.5 | 25.9 | 27.5 | 6.2% |
| Water Quality | 28.5 | 31.6 | 29.1 | -8.1% |
| Drinking Water | 21.7 | 20.1 | 19.7 | -2.0% |
| Hazardous Waste | 48.4 | 43.2 | 33.7 | -21.8% |
| Pesticides | 13.7 | 15.0 | 14.2 | -5.6% |
| Radiation | 2.9 | 1.6 | —1/ | -100.0% |
| Toxic Substances | 24.5 | 26.0 | 25.7 | -1.3% |
| Management | 5.2 | 5.1 | 6.6 | 29.3% |
| Buildings and Facilities | 5.0 | 2.5 | 0.0 | -100.0% |
| Abatement & Control (Environmental Technology) | 0.0 | 0.0 | 12.0 | — |
| **Trust Funds** | | | | |
| Superfund | 66.6 | 69.8 | 60.7 | -13.1% |
| Leaking Underground Storage Tanks | 0.8 | 0.7 | 0.8 | 2.1% |
| Oil Spill Response 2/ | [2.5] | [2.1] | 2.1 | [-1.4%] |
| TOTAL EPA R&D | 492.5 | 511.4 | 547.9 | 7.1% |
| Conduct of R&D | 487.5 | 508.9 | 547.9 | 7.7% |
| R&D Facilities | 5.0 | 2.5 | 0.0 | -100.0% |

Source: OMB data for R&D for FY 1994 and agency budget justification.

1/EPA proposes to fund radiation R&D under the Air Quality program beginning in FY 1994.

2/Amounts shown in brackets indicate funding for oil spill R&D previously included in other lines.

# TABLE II-18. R&D IN THE DEPARTMENT OF EDUCATION

**Table II-18.** R&D in the Department of Education (budget authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | % Change FY 93–94 |
|---|---|---|---|---|
| Rehabilitation Services and Handicapped Research | 50.3 | 51.5 | 50.0 | -3.0% |
| Education Research & Statistics | 42.9 | 45.3 | 55.6 | 22.7% |
| Handicapped Special Purpose Funds | 34.4 | 33.8 | 33.8 | 0.0% |
| Special Institutions for Persons With Disabilities 1/ | 5.8 | 6.1 | 6.3 | 4.6% |
| Vocational and Adult Education | 17.5 | 16.0 | 15.9 | -0.4% |
| Bilingual Education | 1.1 | 0.6 | 1.5 | 172.7% |
| Howard University | 5.2 | 4.8 | 4.8 | -0.7% |
| International Education and Foreign Language Studies | 2.3 | 2.5 | 2.4 | -2.0% |
| Fund for the Improvement of Post Secondary Education | 0.5 | 0.5 | 0.6 | 12.6% |
| All Other | 6.7 | 6.9 | 7.1 | 1.9% |
| TOTAL Education R&D | 166.9 | 168.0 | 178.0 | 6.0% |
| Conduct of R&D | 164.5 | 165.8 | 176.2 | 6.3% |
| R&D Facilities | 2.4 | 2.2 | 1.8 | -18.6% |

Source: Agency budget justification.

1/R&D at Gallaudet University, American Printing House for the Blind, and National Technical Institute for the Deaf.

# Part III

# Disciplinary Analyses

# Introduction

The chapters that follow take a cross-cutting view of the FY 1994 figures for R&D to the preceding agency chapters – summarizing the R&D prospects for some of the major scientific and engineering disciplines and research areas. In each case, the budgets of various agencies that provide support for these disciplinary areas are examined, and policy issues and funding trends are discussed in terms of their impacts on the disciplines. Tables in these chapters, on the whole, contain detail of agency R&D programs not shown in the tables that appear at the end of Part II.

## 12

# Physics in the FY 1994 Budget

*Richard M. Jones, Audrey T. Leath, AIP*

The federal government provides support for physics research through the Department of Energy, the National Science Foundation, the National Institute of Standards and Technology, and the Department of Defense. The Department of Defense does not provide specific data on physics support; consult the DOD chapter for an overview of this budget.

## HIGHLIGHTS

- Changes in Department of Energy physics programs range from a decrease in the Basic Energy Sciences R&D budget of 5.4 percent to a 24.6 percent increase for the Superconducting Super Collider. The completion of the SSC would be delayed by three years and its cost increased by $2 billion. DOE is proposing two new initiatives in FY 1994: a B-Factory and an Advanced Neutron Source.
- The National Science Foundation has requested an 11.2 percent increase in the Physics budget, a 13.5 percent increase for Materials Research, $12.0 million for the National High Magnetic Field Laboratory, and $43.0 million for the Laser Interferometer Gravitational Wave Observatory.
- The National Institute of Standards and Technology budget for intramural physics R&D would increase by 1.9 percent.

## DEPARTMENT OF ENERGY

DOE supports physics R&D within the following programs: General Science and Research, Basic Energy Sciences (BES), and Fusion Energy. General Science and Research, which comprises High Energy, Nuclear Physics, and the Superconducting Super Collider, would receive a 12.8 percent boost for R&D in President Clinton's FY 1994 request. Fusion Energy would gain by 5.0 percent, while Basic Energy Sciences would experience a 5.4 percent decrease, primarily due to a 33.9 percent drop in the BES capital equipment and construction account.

Two new physics initiatives are being requested for FY 1994: a B-Factory, to be funded within High Energy Physics, and an Advanced Neutron Source (ANS) at Oak Ridge National Laboratory, for which $39.0 million is requested. The ANS is intended to replace two aging facilities: the High Flux Beam Reactor and the High Flux Isotope Reactor.

According to DOE's budget "Highlights," the ANS request "would fund the design and construction of an advanced neutron source to serve as a national user facility to perform materials research, to produce rare isotopes for medical diagnosis, treatment, and research, and to perform research using neutron irradiation techniques. The facility would accommodate approximately 1,000 user groups from industry, universities, and federal laboratories. The total projected cost of the facility is about $2.7 billion."

### *High Energy Physics*

DOE has requested $627.8 million for High Energy Physics for FY 1994, an increase of 2.4 percent above the FY 1993 appropriation. The request includes:

- $148.6 million for university and laboratory based experimental and theoretical research,
- $268.4 million for facility operations,
- $59.4 million for High Energy Physics technology, and
- $65.1 million for capital equipment.

A total of $86.3 million for construction projects includes:

- $25.0 million for continuing construction of the Fermilab Main Injector (total estimated cost of $229.6 million);
- $36.0 million for the B-Factory.

The B-Factory is labeled in the DOE "Highlights" as a departmental investment initiative "that funds the design and construction of a high luminosity electron-positron colliding beam machine for the purpose of studying the fundamental aspects of the structure of matter." Site selection would be made jointly with the NSF.

## Nuclear Physics

The FY 1994 request for Nuclear Physics is $322.3 million, an increase of 4.3 percent over the FY 1993 appropriation. A total of $199.3 million is requested for operating expense program support, which includes:

- $91.5 million for Medium Energy Physics,
- $67.4 million for Heavy Ion Physics,
- $25.6 million for Low Energy Physics, and
- $14.8 million for Nuclear Theory.

The request for capital equipment is $29.0 million. Construction funding of $94.0 million would include funds to continue construction of the Relativistic Heavy Ion Collider (RHIC) and the Continuous Electron Beam Accelerator Facility (CEBAF).

- RHIC would receive $70.0 million (total estimated cost of $477.3 million).
- CEBAF would receive $16.6 million (total estimated cost of $313.2 million).

The Nuclear Physics request also includes funding to complete closure of the Bevelac at Lawrence Berkeley Laboratory, and to initiate phaseouts of the Los Alamos Meson Physics Facility (LAMPF) and the Electron Linear Accelerator at Oak Ridge National Laboratory.

## Superconducting Super Collider

Within the $640.0 million SSC request, R&D would total $627.6 million, an increase of 24.6 percent from FY 1993. However, the Clinton Administration has asked DOE to stretch out completion of the SSC by three years. The DOE Budget "Highlights" provide the following information: "Currently the Department is re-estimating the project completion and total project cost as a result of the most recent FY 1994 Presidential budget guidance which calls for a stretch-out of the SSC program to ensure that all components are technically effective and that adequate managerial controls are in place. . . . The impact of the reevaluation is a reduction in planned outlays in FY 1994-1998, a 3-year delay in schedule, and a $2 billion increase in the as-spent project cost. This estimate of the change is believed accurate within 20 percent at this time."

The $640.0 million total request (including program direction) is apportioned as follows:

- $104.4 million for continued research and development on superconducting magnets and other accelerator and detector systems,
- $50.0 million for capital equipment, primarily for prototypes of detector and accelerator subsystems,
- $480.6 million for construction, primarily for detailed design of both technical and conventional facilities, the magnet industrialization program, fabrication of injector and collider technical systems and components, and on-site construction of conventional facilities, and
- An additional $5.0 million is included for laboratory operations not directly related to project construction.

The "Highlights" note that DOE expects "substantial non-Federal contributions."

## Basic Energy Sciences

The FY 1994 request for R&D within Basic Energy Sciences is $792.6 million, a decrease of 5.4 percent from the FY 1993 appropriation. The request includes the following amounts for the six major BES research areas:

- $277.0 million for materials sciences,
- $169.0 million for chemical sciences,
- $106.2 million for applied mathematical sciences,
- $37.9 million for engineering and geosciences,
- $26.7 million for energy biosciences, and
- $11.4 million for advanced energy projects.

Capital equipment would receive $44.9 million. A total of $119.5 million requested for construction projects includes $107.0 million for the 6-7 GeV Synchrotron Radiation Source at Argonne National Laboratory.

DOE's budget "Highlights" describe the BES programs as follows:

> BES has a heavy involvement in major scientific user facilities: the High Flux Beam Reactor and the National Synchrotron Light Source at Brookhaven National Laboratory; the Combustion Research Facility at Sandia National Laboratories, Livermore; the High Flux Isotope Reactor and the Radiochemical Engineering Development Center at Oak Ridge National Laboratory; the Stanford Synchrotron Radiation Laboratory at Stanford University; the Intense Pulsed Neutron Source at Argonne National Laboratory; and the 1-2 GeV Synchrotron Radiation Source at Lawrence Berkeley Laboratory.

In addition to these existing facilities, the BES program is also supporting construction of a major new scientific facility, the 6-7 GeV Synchrotron Radiation Source. Operation of these facilities account for $192.5 million of the BES funding requirements.

### Fusion Energy

Within Fusion Energy, DOE has requested $338.4 million for Magnetic Fusion R&D, an increase of 5.0 percent over the FY 1993 appropriation. According to the DOE budget "Highlights," four essential elements of the fusion plan are all supported by the FY 1994 budget:

> The first is conducting deuterium-tritium experiments at the Tokamak Fusion Test Reactor (TFTR), making TFTR the first program to perform extensive D-T experiments to provide important data on plasma self-heating. The second is U.S. participation in the engineering design phase of the International Thermonuclear Experimental Reactor (ITER). The purpose of ITER will be to demonstrate many of the reactor technologies needed for fusion power. The third element involves supporting construction of an experimental facility to develop advanced tokamak modes that could lead to more efficient and, therefore, a more attractive demonstration reactor. The Tokamak Physics Experiment (TPX) will have the capability to operate for long pulses and to develop advanced tokamak operating modes. The TPX effort is a Departmental investment initiative. Conceptual design is being completed and initiation of Title I design will begin in FY1994. The fourth element is a strong base physics and technology research program required to support ITER, TPX, and a demonstration reactor.

While DOE's Fusion Energy program focuses primarily on Magnetic Fusion, an additional $4.0 million has been requested for Inertial Fusion Energy, to continue research on heavy ion accelerators. This is a 42.0 percent reduction from FY 1993.

## NATIONAL SCIENCE FOUNDATION

Most of the National Science Foundation's support for physics is contained in three subactivities: Physics, Materials Research, and Major Research Equipment.

The Administration has requested an increase of 11.2 percent in the Physics budget for FY 1994. Materials Research funding would increase 13.5 percent. The Major Research Equipment budget request contains $12.0 million for the National High Magnetic Field Laboratory and $43.0 million for the Laser Interferometer Gravitational Wave Observatory.

## Physics Support

Although physics research receives considerably more funding from the Department of Energy, NSF support for basic research in physics at universities is very important. Just under 50 percent of all federal support for basic research in physics is provided by NSF through this subactivity, varying by subdiscipline from approximately 33 percent to almost 100 percent.

Previous NSF budgets have broken down the Physics Subactivity budget request into five program elements: elementary particle physics; nuclear sciences; atomic, molecular, optical physics; theoretical physics; and gravitational physics. This structure has been dropped, the NSF budget document states, "in order to simplify the budgetary presentation." Funding is now categorized under Research Project Support and Facilities.

Direct comparisons in funding levels between previous fiscal years and the FY 1994 request for Physics are difficult. In FY 1993, Physics funding totals $128.23 million. For FY 1994, NSF requested $142.60 million, a $14.37 million or 11.2 percent increase. This spending was divided as follows:

- For Research Project Support in FY 1994, NSF requested $106.85 million.
- For Facilities support in FY 1994, NSF requested $35.75 million.

NSF's budget document describes increases in Research Project Support. It is important to note that these increases use as a baseline projected NSF spending which would have been possible had the economic stimulus bill been passed by Congress. At press time, no further legislation had been passed, and thus the numbers below are somewhat inaccurate. The amount of these increases should be used as an indication of the direction of NSF proposed spending, with less attention given to specific numbers:

$1.0 million increase for High Performance Computing and Communications to explore approaches to advanced problem solving in parallel computing;

$1.20 million increase for Advanced Materials and Processing, Manufacturing, and Environmental Sciences to investigate the characteristics of materials irradiated with ultra-high power laser light of extremely short duration, the science of nanolithography using light forces acting on atomic beams, and environmental matters; and

$1.50 million increase to strengthen research activities of undergraduate students and faculty at many colleges and universities around the nation."

Increases in Physics Facilities funding are described in the NSF budget document, qualified as above, and are as follows:

$2.0 million increase for improving the luminosity of the Cornell Electron Storage Ring; and

$1.10 million for development of compact superconducting cyclotrons, improving the quality of materials in superconducting accelerator applications, and enhancing data processing and communication in conjunction with FCCSET initiatives in Biotechnology, AMPP (Advanced Materials and Processing), and HPCC (High Performance Computing and Communications).

## Materials Research

Important support is also provided by NSF's Materials Research Subactivity. Approximately 50 percent of total federal support in Materials Research at universities is provided by NSF.

NSF support for Materials Research in the current fiscal year is $150.57 million. NSF requested an increase of $20.38 million, or 13.5 percent, bringing the FY1994 request to $170.95 million. This request was divided as follows:

- For Materials Research Project Support, NSF requested $92.41 million.
- For Materials Research Centers and Groups, NSF requested $56.44 million.
- For National Facilities and Instrumentation, $22.10 million was requested.

The NSF budget document describes increases in this subactivity as follows, again qualified as described above:

"The Materials Research Subactivity plays a lead role in the Advanced Materials and Processing program, with its focus on support for research involving new approaches to the synthesis, processing, preparation, and characterization of materials with new, unique, or superior properties. Linking the goals of this central FCCSET initiative with those of the others is an emphasis for the Materials Research Subactivity across all its programs.

"Materials Research Project Support increases by $4.70 million, or 5.4 percent, providing:

"Resources for developing new and essential scientific and engineering knowledge for technological advances. These are critically dependent on the synthesis and processing of novel and advanced materials.

"Materials Research Centers and Groups increases by $3.50 million, or 6.6 percent, providing:

Resources to enable NSF to establish new Materials Research Centers and Groups (MRCGs). The MRCGs will provide support for interdisciplinary research and education in strategic areas of materials, strengthening the technology and human resource base in materials and their applications and forging strong links with industry and other sectors.

"National Facilities and Instrumentation increases by $3.20 million, or 16.9 percent, providing:

Establishment, in collaboration with the Engineering Activity, of a national nanofabrication users facility network.

Construction of at least one synchrotron radiation beamline and the acquisition of other major instrumentation for materials research."

## Major Research Equipment

A third important category of NSF support for physics is Major Research Equipment. ~~Two~~ projects are notable: the Laser Interferometer Gravitational Wave Observatory (LIGO) and the High Magnetic Field Laboratory (HMFL).

NSF requested $12.0 million for the HMFL for FY 1994. The budget document notes that full operation of the laboratory is planned in 1994, at a total completion cost of $140.0 million. More than half this amount will be provided by the State of Florida.

The request for LIGO is $43.0 million. Completion is expected by 1998 for a total expenditure of $229.10 million.

## NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NIST's intramural Physics R&D would receive $24.4 million, an increase of 1.9 percent over FY 1993. NIST supports basic physics research in quantum, electron, optical, atomic, molecular, and radiation physics, as well as research on quantum-level measurement methods and improved time and frequency standards.

The NIST budget "Highlights" provide examples of FY 1994 physics research: "developing improved ways to study how chemical reactions proceed and how they might be better controlled; developing electronic and optical methods to better understand the behavior of advanced materials and devices in industrial applications; and advancing the sensitivity of optical measurements to enhance detection of trace elements, provide more secure communications, and improve optical and microwave frequency control."

Intramural R&D in Materials Science and Engineering would total $36.4 million, a 23.9 percent increase over FY 1993. According to the NIST "Highlights," "research supported by the program covers the full range of issues affecting the development and use of advanced materials from processing to performance to design."

# 13

# Astronomy in the FY 1994 Budget

*Peter B. Boyce, AAS*

## HIGHLIGHTS

It is a time of great change in Washington and the funding of astronomy has not escaped being affected. As part of the President's supplemental request for FY1993, astronomy would have benefitted, but the request failed in Congress. Both NASA, facing space station redesign problems, and NSF, with a large proposed increase, will have trouble in the congressional budget process.

- Within NSF, a special budget line for Major Research Instruments contains $14 million for continuing the construction of a pair of modern 8-meter optical telescopes. Having secured five international partners, the project has satisfied a congressional mandate that half the cost come from non-U.S. sources.
- Funding for construction of a Laser Interferometer Gravitational Observatory (LIGO) is also included, but a substantial portion of the construction money is likely to come from cuts in the research grant portion of the Physics Division budget.
- The NASA budget has been reorganized into two segments, one including the "core" program of scientific missions, shuttle flights, etc. The other portion contains the space station development plus the advanced technology programs and any new science missions. The

actual amount of funding for the advanced science missions and non-station development will depend upon the cost of the redesigned space station which will not be known until June.

- The Mission Operation and Data Analysis portion of the NASA budget has been kept level despite the needs arising from a growing number of operating missions.
- In order to stay within a constrained overall NASA budget, the Advanced X-Ray Astronomy Facility (AXAF) has been split into two missions, one for imaging and one for spectroscopy. With each mission being smaller, lighter and cheaper, substantial economies have been made while retaining most of the original scientific capability.
- The new budget includes $40 million for a new start for the Gravity Probe-B mission, acknowledging the past congressional practice of restoring the mission whenever NASA has failed to include it in the President's budget.

## INTRODUCTION

As in previous years, we will limit our analysis of the astronomy budget to the two agencies which provide over three quarters of the federal funding for astronomical research, NASA and NSF. These agencies supply virtually all of the federal funding for individual research grants. Other agencies, such as the Smithsonian Institution, the Department of Defense, the Department of Energy, etc., also fund research of interest to astronomy, but they play a smaller role in the picture of federal support for astronomy. In general, their funding is restricted to support of their own research projects.

## ASTRONOMY IN THE NASA BUDGET

According to recent analyses of awards, NASA now provides the bulk of the money to fund individual investigators. Astronomy in NASA is included in both their Physics and Astronomy and their Planetary Exploration programs. Physics and Astronomy, however, budget lines do give an indication of how well astronomy is faring.

The NASA budget tables are given elsewhere in this volume. The following NASA budget lines may need explanation:

*Shuttle/Spacelab Payload Mission Management & Integration* provides support for the planning, integration, and execution of all

Spacelab and attached shuttle payloads. This includes payload specialist training, payload flight operations, and data dissemination to the experimenters.

*Payload and Instrument Development* is designed to accommodate development of specific instruments to be flown on the shuttle, as free-flyers or on foreign flights.

*Mission Operations and Data Analysis* supports the operating costs of current missions and funds the analysis of data from current and past missions. The entire scientific output of a mission is supported by these funds.

*Research and Analysis* supports general research relevant to NASA's missions and provides the advanced technology development needed to plan future missions. Funding for early exploratory work on the difficult, pacing items for future missions, such as the Space Infrared Telescope Facility (SIRTF), fall in this budget line as does the Astrophysics Theory Program and grants to individual investigators.

*Suborbital Programs* supports the flights of aircraft, balloons and rockets. These vehicles provide low-cost platforms for developing instrumentation and provide frequent opportunities for making vital supporting observations.

NASA is now reworking its budget plans to accommodate a future of level budgets instead of assuming a growth rate of seven percent.

NASA now acknowledges the impossibility of operating all the current and planned missions at their presently planned level of expenditure. The agency has committed to reducing the MO&DA budget. In response to the growing number of operating science missions, this budget line has grown rapidly in recent years. It had been expected that this line would increase substantially this year. The President's budget requests an amount which is virtually identical with the FY 1993 level.

- The Mission Operations and Data Analysis line of all the Space Science programs are proposed to remain at last year's level. Since many of the costs for operating spacecraft are fixed, cuts will have to be made to various data analysis programs which support grants to the scientific community.

- The Hubble Space Telescope (HST) continues to produce exciting discoveries and excellent science. The proposed level funding for MO&DA will affect operation of the HST. Less money will be available for scientific analysis of the data and development of one of the proposed second-generation instruments will probably have to be terminated. However, development of the first repair and refurbishment mission, to be launched in December, is proceeding well.

- The CASSINI mission to Saturn is proposed to receive $267 million, an increase of 30 percent.
- The restructured AXAF mission will enter the development phase and is proposed to receive $260 million, a 55 percent increase.
- The Gravity Probe-B mission will receive a new start, with $40 million proposed for the first year.
- The Research and Analysis base in Planetary Exploration, upon which the community of individual researchers depends, is proposed to increase to $126 million.
- The small explorer program of three university-class missions is proposed to be funded adequately. The Submillimeter Wave Astronomy Satellite (SWAS), the only small explorer for astrophysics, is still scheduled for a 1995 launch.
- The Extreme Ultraviolet Explorer, launched last year, has been performing well. However, this successful mission will apparently also feel a squeeze in its operating budget.

## ASTRONOMY IN THE NSF BUDGET

If we ignore the President's supplemental request for FY 1993, which failed in Congress, astronomy support at NSF has a proposed 10 percent increase, smallest of all the divisions within the Directorate for Mathematics and Physical Sciences. Within the National Science Foundation, most astronomical research is supported within the Division of Astronomical Sciences. The support for astronomical research in other divisions is not specifically enumerated and is difficult to separate out. The budget trends for the Division of Astronomical Sciences are indicative of the NSF support for astronomy.

Through contractors, NSF operates three National Observatories which are available to qualified scientists under an extensive visitor-use program. The National Observatories have major telescopes and some smaller instruments which have a long history of productive use. Under the Research Support budget line, NSF supports a program of peer-reviewed research grants to individual investigators and to research groups located at universities and research observatories.

The significant aspects of the NSF FY1994 budget for astronomy are as follows:

- NSF will provide $14 million to continue construction of two modern 8-meter optical telescopes, one in each hemisphere. Congress mandated that half the cost be provided by foreign partners. As of April, 1993, that requirement has been met.
- Exclusive of the 8-meter funds, NSF Astronomy, which took a substantial cut in FY 1993, is slated to receive an overall budget increase of 10.2 percent, which is only 1.2 percent above the 1992 level.
- NRAO will continue refurbishment of the Very Large Array in 1992, including replacement of deteriorating railroad ties and repair of the transporter for moving the telescopes. Construction of the 100-meter diameter Green Bank Telescope will continue, using funds supplied in previous years.
- At NAIC, an upgrade of the Arecibo radio telescope will continue. The upgrade includes the design and construction of a highly efficient, all-frequency secondary mirror and the erection of ground screen to reduce the effects of spurious radio signals. The expected 3- to 10-fold improvement in the world's most sensitive radio telescope will keep this venerable instrument competitive for the next decade.
- The NOAO operating funds will fall well below the inflation rate. The Cerro Tololo Interamerican Observatory in Chile continues to be squeezed by inflation and exchange rate problems in that country.
- In the Research Project Section, which funds the university grants, the President's budget proposes a 13 percent increase to $40.78 million, specifically to allow an increase in the size of individual grants and to support a program of active optics designed to remove some of the deleterious effects of the earth's atmosphere.

Within the Astronomy Project Support Section, the distribution of money among the programs is driven by proposal pressure and by transfer of responsibility for the larger grants from program to program as the emphasis shifts from instrumentation to research on stars, or to extragalactic research, or back to instrumentation. The budget requests for the individual programs of research grants generally do not reveal specific shifts in emphasis by the agency and, therefore, have not been listed separately.

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# FY 1994 R&D in the Atmospheric and Oceanic Sciences

*H. Frank Eden, AMS*

## INTRODUCTION

The U.S. Global Change Research Program involves aspects of many agency budgets in an interdisciplinary fashion. Tracking these contributions into the disciplines is possible in most agencies but complicated. The program grows to $1.48 billion in FY 1994 with the largest increases in Observations and Data Management. In particular, large portions of the NASA budget cannot be assigned on a disciplinary basis. Accordingly, the usual cross-cut table is included in this chapter but not totaled and without a NASA line. In general, however, it is clear from most agency budgets that the FY 1994 proposal requests increases for both disciplines.

## NATIONAL AERONAUTICS & SPACE ADMINISTRATION (NASA)

NASA's overall budget increases by 6.5 percent to $15.26 billion in FY 1994 with a significant investment in the development of new technology. The new Mission to Planet Earth Office continues the development of EOS, EOSDIS and the Earth Probes. It continues operating the Ocean Topography Experiment, TOPEX (launched in August 1992), and the Upper Atmosphere Research Satellite, UARS (launched in September 1991).

Several programs that relate to upper atmosphere research, in the Physics and Astronomy Program, are now part of the new Office of Space Science and are noted also. The Global Geospace Science Mission (part of the U.S. contribution to the International Solar Terrestrial Physics Program, ISTP) decreases to $13.3 million in FY1994. Approximately 20 percent of the Research and Analysis support in the Physics and Astronomy Program is for space science. Similarly, a significant portion of the Sub Orbital Program of sounding rockets, airborne science and balloon launches is in support of atmospheric sciences.

## NATIONAL SCIENCE FOUNDATION (NSF)

The overall FY 1994 request for NSF is at $3.18 billion, an increase of 8.2 percent over the FY 1991 appropriation. There is an emphasis on five Critical Research and Technology Priorities: Advanced Materials, Biotechnology, Global Change, High Performance Computing and Advanced Manufacturing.

Atmosphere Sciences Project Support increases by $3.33 million, or 4.2 percent, with increases in: Global Change Research ($1.04 million); support of individual investigator research and the U.S. Weather Research Program ($1.67 million); and High Performance Computing ($0.62 million).

The National Center for Atmospheric Research (NCAR) increases by $3.50 million, or 6.3 percent, with increases in: Global Change research and facility support ($0.4 million); operation of research facilities such as aircraft, radars, remote sensing devices and computers ($1.60 million); conversion of a surplus military C-130 aircraft into a research aircraft, ($0.50 million); High Performance Computing ($1.00 million).

Upper Atmospheric Facilities support increases $650,000, or 9.1 percent, with increases in: Global Change research (0.1 million); upgrading computer hardware and software at the Sondrestrom Radar (0.2 million); operating and maintaining upper atmospheric radar facilities in the United States, Puerto Rico, Greenland, and Peru ($0.35 million).

In total, the support for Global Change research within ATM increases by $1.54 million to a total of $45.02 million.

Ocean Sciences Research Support increases, by $4.39 million, or 4.1 percent, with increases in: Global Change research, including the joint expedition to the Indian Ocean and Arabian Sea ($2.13 million); collaborative research in coastal oceanography and for oceanic ridge crest processes ($2.05 million), and High Performance Computing ($0.2 million).

Oceanographic Centers and Facilities increases by $6.50 million, or 12.9 percent, with increases for procurement of an Arctic research vessel, through charter or purchase ($6.50 million).

The Ocean Drilling Program (ODP) increases by $2.65 million, or 7.0 percent, to meet the increased contribution in ODP support by the international partners.

In total, support for Global Change research within OCE increases by $2.13 million to $66.23 million.

The above figures do not include support for the Atmospheric and Oceanic Sciences from the Division of Polar Programs. The Arctic Research Program provides support for atmospheric and oceanic research and is proposed in FY 1994 for $26.2 million. Antarctic Program support for atmospheric and oceanic research is approximately 40 percent of the Antarctic Research Program's budget of $28.5 million in FY 1994.

## DEPARTMENT OF DEFENSE (DOD)

The budget projections for DOD are estimates based upon FY 1992 obligations, FY 1993 organizational budgets and the FY 1994 budget submission. The FY 1993 and the FY 1994 estimates are subject to change.

Army research in atmospheric sciences focuses strongly on the planetary boundary layer and support to army weapon systems. Research includes theory and technique development to document atmospheric effects on electro-optical and infrared propagation, focusing on the battlefield environment. Research also aims toward improved atmospheric and signature characterization capabilities. Research in airflow over complex terrain and atmospheric transport and diffusion addresses a broad range of Army and DoD needs. Exploratory work to evaluate new sensor technologies, such as atmospheric profiling, continues in efforts to develop battlefield remote sensing capabilities. A centerpiece of the Army development program is the integration of weather events and effects into realistic models/simulations and weather decision aids. In addition, the Army is beginning atmospheric pollution research having both military and civilian applications.

The Air Force research program also focuses on a wide range of research needs. The Air Force emphasis is changing from large-scale to mesoscale dynamic modeling with a focus on air base and battlefield forecasting of clouds. On a more limited scale, research is continuing on refining the weather impact on electro-optical tactical decision aids designed to support a number of specific Air Force tactical systems and operations. In other areas, emphasis is being placed on satellite remote sensing capabilities, such as the vertical sounding for temperature and water vapor, and the development of algorithms for the three-dimensional description of cloud fields. Technology development continues in the area of advanced meteorological data processing, incorporating expert systems concepts to fuse data from various sources, such as radar, satellite and other ground-based sensors.

Atmospheric science research funded by ONR consists of two primary thrusts, marine planetary boundary layer and oceanic storms. Marine boundary layer research is directed toward understanding the physical processes governing the evolution of the lowest 2 km of the atmosphere over the ocean and in coastal regions. Oceanic research has two major components, midlatitude extratropical cyclogenesis and western Pacific tropical cyclones. In other areas, efforts are underway to introduce new capabilities in meteorological and oceanographic data acquisition, processing and presentation through the introduction of the third generation Tactical Environmental Support System (TESS-3) to major combatant ships.

Oceanographic research includes small-scale physical oceanography, mesoscale and large-scale circulation and structure, ocean geophysics (bottom characterization, thermal vents), ocean acoustics (noise sources and character, acoustic propagation), and ocean biology. Ocean circulation efforts ultimately focus on the development of eddy-resolving global and regional oceanographic numerical models. The increase in FY 1994 is reflective of emphasis being placed on ocean sciences by ONR.

Not specifically included in the budget table is funding for the DOD University Research Initiative (URI) programs in atmospheric and ocean sciences. In FY 1994, approximately $4.4 million is supporting URI programs in atmospheric, ocean and space environmental sciences.

## NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION (NOAA)

The NOAA request for FY 1994 of $1.59 billion for Operations, Research and Facilities represents a significant increase over FY 1993 obligations primarily in the National Weather Service and the National Environmental Satellite and Data and Information Service.

In the National Ocean Service, all program activities are reduced. The associated fleet modernization program is reduced by $4.5 million to $23.0 million.

In Oceanic and Atmospheric Research, the Climate and Global Change program funding is $69.9 million, an increase of $23.0 million over FY 1993; all other programs are reduced by a total of $17.9 million.

The National Weather Service is proposed for an increase of $140.0 million. NEXRAD and related procurements increase by $19.7 million and acquisition of AWIPS and NOAA PORT equipment are emphasized.

In the National Environmental Satellite, Data, and Information Services (NESDIS), the FY 1994 request increases by approximately $82.5 million and provides for maintaining a geostationary satellite (GOES) system with the GOES I through M procurement and a polar-orbiting satellite system with continuation of the NOAA KLM series, support for NOAA N and N', and support of instruments for the first European METOP Satellite.

Program Support increases by approximately $8.0 million in FY 1994. NOAA ship time is reduced by $1.0 million.

## OTHER AGENCIES

Due to the late publication of the President's FY 1994 Budget Report, it was not possible in this analysis to include support from other agencies as is usually reported in this chapter. These agencies include DOA, DOE, USGS, MMS, and DOI.

**Table 1.** R&D in the Atmospheric and Ocean Sciences (Budget Authority in millions of dollars)

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| Atmospheric | | | |
| NASA[1] | ----- | ---- | ---- |
| NSF | 126.5 | 141.8 | 149.1 |
| DOD | 64.9 | 70.6 | 70.7 |
| DOC (NOAA) | 130.1 | 147.1 | 192.6 |
| Oceanic | | | |
| NASA | ---- | ---- | ---- |
| NSF | 177.5 | 196.2 | 209.8 |
| DOD | 111.3 | 115.0 | 119.7 |
| DOC (NOAA) | 95.6 | 93.1 | 84.7 |

[1] It is not possible to divide the FY 1993 NASA budget accurately between the two disciplines.

**Table 2.** R&D in NASA's Atmospheric and Ocean Sciences Office of Mission to Planet Earth

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| Earth observing system | 176.4 | 263.8 | 322.7 |
| EOS data information system | 77.7 | 130.6 | 182.7 |
| Earth probes (including Scatterometer) | 77.8 | 99.4 | 97.3 |
| Remotely piloted aircraft | ---- | ---- | ---- |
| Upper atmosphere research satellite mission | 62.0 | ---- | ---- |
| Ocean topography experiment | 65.0 | ---- | ---- |
| Payload and instrument development | 37.9 | 35.4 | 22.9 |
| Mission operations and data analysis | 100.6 | 147.5 | 160.8 |
| Interdisciplinary research | 2.3 | 4.4 | 5.0 |
| Modeling and data analysis | 45.8 | 42.6 | 45.0 |
| Process studies | 121.5 | 119.3 | 131.5 |
| Airborne science and applications | 20.3 | 20.7 | 25.2 |
| Mission to planet earth information systems | ---- | ---- | 11.8 |
| Research operations support | 83.9 | 70.1 | 67.0 |
| **TOTAL** | 812.2 | 933.8 | 1,071.9 |
| Physics and Astronomy, Office of Space Science. | | | |
| Global geospace science | 75.3 | 72.6 | 13.3 |
| Research and analysis | 69.9 | 71.5 | 72.2 |
| Suborbital program | 60.1 | 64.8 | 69.5 |

**Table 3.** R&D in NSF's Atmospheric Sciences

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| Atmospheric Sciences Project Support | 68.5 | 78.6 | 81.9 |
| National Center for Atmospheric Research | 51.4 | 55.7 | 59.2 |
| Upper Atmospheric Research Facilities | 6.6 | 7.3 | 7.9 |
| **TOTAL** | 126.5 | 141.6 | 149.0 |

**Table 4.** R&D in NSF's Ocean Sciences

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| Ocean Sciences Project Support | 90.0 | 108.2 | 112.6 |
| Oceanographic Centers and Facilities | 51.2 | 50.2 | 56.8 |
| Ocean Drilling Program | 36.3 | 37.8 | 40.4 |
| **TOTAL** | 177.5 | 196.2 | 209.8 |

**Table 5.** R&D in DOD's Atmospheric Oceanic Sciences

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| Atmospheric Sciences | | | |
| Army | 12.8 | 14.7 | 13.8 |
| Navy | 18.3 | 20.6 | 23.1 |
| Air Force | 33.8 | 35.3 | 33.8 |
| **Subtotal** | 64.9 | 70.6 | 70.7 |
| Oceanic Sciences | | | |
| Navy | 111.3 | 115.0 | 119.7 |

**Table 6.** The National Oceanic and Atmospheric Administration

| | FY 1992 Actual | FY 1993 Estimates | FY 1994 Estimates |
|---|---|---|---|
| National Ocean Service | ---- | 167.9 | 148.8 |
| National Marine Fisheries | ---- | 223.0 | 224.0 |
| Oceanic & Atmospheric Research | ---- | 202.2 | 214.1 |
| National Weather Service | ---- | 532.7 | 673.1 |
| NESDIS | ---- | 346.7 | 429.2 |
| Program Support | ---- | 142.1 | 145.1 |
| **TOTAL** | ---- | 1,614.5 | 1,834.7 |

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# Earth Sciences in the FY 1994 Budget

*Craig M. Schiffries, AGI*

### HIGHLIGHTS

- The Earth Sciences Division of the National Science Foundation is requesting a budget increase of 18.4 percent to $89.7 million in FY 1994. An increase in FY 1994 would redress the decrease in FY 1993.
- Of the $19 million proposed for ecological risk assessments, $11.5 would come under Multimedia and the remainder under the media programs (*e.g.*, Pesticides, Toxic Substances, Hazardous Waste, and Superfund). Funding for the Geologic Division of the U.S. Geological Survey would remain constant at $221 million in FY 1994, which would represent a decline of about 3 percent after adjusting for inflation.
- The Office of Fossil Energy in the Department of Energy is requesting appropriations of $398.4 million in FY 1994, a decrease of 4.8 percent. Substantial increases in petroleum and natural gas programs would be offset by a large decrease in coal R&D programs.
- The FY 1994 budget request for NASA's Mission to Planet Earth is $1,074.9 million, an increase of 14.6 percent over FY 1993.
- Interagency initiatives under the Federal Coordinating Council on Science, Engineering and Technology

(FCCSET) play an key role in federal earth sciences R&D activities.

This chapter focuses on the President's FY 1994 budget request for solid-earth sciences R&D in the National Science Foundation (NSF), the U.S. Geological Survey (USGS), the Department of Energy (DOE), and NASA. Complementary chapters provide detailed information about atmospheric and oceanic sciences, and water resources.

## EARTH SCIENCES AND SOCIETY

The earth sciences play an increasingly important role in a growing range of societal issues. The National Research Council (NRC) recently released a report, *Solid-Earth Sciences and Society,* that illustrates how earth sciences research and information enhance society's ability to make wise decisions on resource development, waste disposal, environmental protection, natural hazards reduction, and land use. The NRC report includes a comprehensive study of solid-earth sciences expenditures in the federal budget for FY 1990, the latest year for which a complete analysis has been conducted.

Federal investments in earth sciences research and development continue to pay enormous dividends. For example, the U.S. Geological Survey reports that the successful prediction of the 1991 eruption of Mt. Pinatubo in the Philippines saved thousands of lives and billions of dollars in U.S. military equipment.

In addition to recognizing the return on federal investments in earth sciences R&D, it is important to emphasize the need to maintain the health of the basic science on which applications and policy decisions must be ultimately based.

## NATIONAL SCIENCE FOUNDATION

The FY 1994 budget request for the National Science Foundation is $3.18 billion, an increase of $447 million, or 16.3 percent, over the FY 1993 current plan. The budget request for Research and Related Activities is $2.20 billion, an increase of $345.8 million or 18.6 percent. A substantial increase in FY 1994 appropriations for Research and Related Activities would redress last year's $12 million cut relative to FY 1992. If the FY 1994 budget request were enacted, the average annual growth rate for Research and Related Activities over the past two years would be nearly 6.5 percent after adjusting for inflation.

The budget request for the NSF Directorate for Geosciences is $448.5 million, an increase of $68.8 million or 18.1 percent (Table 1).

The growth rate of the Geosciences Directorate would be slightly less than that of total Research and Related Activities, which includes all scientific disciplines.

The FY 1994 budget request for the Earth Sciences Division is $89.7 million, an increase of $13.9 million or 18.4 percent. The budget for the Earth Sciences Division has three components (Table 2): earth sciences project support, which would increase 14.5 percent to $57.3 million; continental dynamics, which would increase 15.5 percent to $7.5 million; and instrumentation and facilities, which would increase 29.2 percent to $24.9 million.

Interagency R&D initiatives coordinated by the FCCSET continue to play an important role in the Earth Sciences Division. Increases in support for FCCSET initiatives would account for about 25 percent of the total increase in the FY 1994 budget request for the Earth Sciences Division. The U.S. Global Change Research Program accounts for the vast majority of Earth Sciences support for the FCCSET initiatives; support for that program would increase by 31.1 percent to $13.6 million in FY 1994. The Earth Sciences Division plays a small, but rapidly increasing role in the High Performance Computing and Communications initiative and the Advanced Materials initiative.

Additional highlights in the FY 1994 budget request for the Earth Sciences Division are the following:

- Support for hydrologic sciences would increase by 25.0 percent to $2.5 million in FY 1994.
- The increase in instrumentation and facilities would provide $3.0 million for acquisition and deployment of digital seismographs to enhance capabilities of the Global Seismic Network.
- Cooperative Studies of the Earth's Deep Interior (CSEDI) would receive $0.5 million of new funds.
- Funding for the National Earthquake Hazards Reduction Program (NEHPR) would remain constant at $10.90 million.

## DEPARTMENT OF INTERIOR

### U.S. Geological Survey

The U.S. Geological Survey (USGS) is the primary earth sciences research organization in the federal government. Upon releasing the bureau's FY 1994 budget request, Interior Secretary Bruce Babbitt said, "The USGS budget reflects the new administration's understanding that investing in America requires investing in a strong earth science capability. We need high quality scientific information on natural hazards and on our water, mineral, energy and land resources to serve as the building blocks for making intelligent decisions and planning for future growth."

The FY 1994 budget request for the USGS is $598 million, an increase of $21.2 million or 3.7 percent over FY 1993. Despite the growing importance of its mission, the USGS budget failed to keep pace with inflation during the past twelve years. From FY 1981 to FY 1993, the total USGS budget (appropriated funds and other sources of income) declined by 8 percent in constant dollars, and the budget for the Geologic Division declined by 28 percent.

The FY 1994 budget request for the Geologic Division is $221.0 million, which is nearly identical to its FY 1993 appropriations.

Although the budget for the Geologic Division would remain nearly unchanged in current dollars, it would decline by about 3 percent in real dollars based on the Office of Management and Budget's estimated GDP deflator for FY 1994.

Table 3 shows that the budgets for five of the six subactivities in the Geologic Division would decline by 0.1 to 0.8 percent from their FY 1993 levels. The only subactivity that would post a budget increase in FY 1994 is Geologic Framework and Processes, which includes $1.2 million in new funds to further implement the National Geologic Mapping Act of 1992.

The budget request for several programs in the Geologic Division represents a significant departure from the past. In recent years, the President's annual budget proposal called for substantial reductions in funding for certain popular programs, such as geologic hazards surveys, and each year Congress restored many of the proposed budget cuts. This year, the budget requests for those programs are close to their current funding levels, and Congress will not be called upon to restore deep cuts in their budgets.

## Other Bureaus

Earth sciences highlights in the FY 1994 budget request for other bureaus of the Department of the Interior include the following:

- President Clinton and Secretary Babbitt announced a proposal to create a National Biological Survey, which would have many parallels with the USGS.
- The Bureau of Mines is requesting an 18 percent decrease in its research budget to $89.7 million, including a 12

percent decrease in Minerals and Materials Science to $23.0 million, and a 98 percent decrease for Mineral Institutes.

- The Minerals Management Service is requesting constant funding of $19.6 million for resource evaluation of outer continental shelf lands.
- The Bureau of Reclamation is requesting $11.5 million, an increase of 24.2 percent, for its Science and Technology program, which conducts studies related to water resources and global change.
- The Bureau of Land Management is requesting $20.1 million, an increase of $0.6 million, for its Soil, Water, and Air Management program.

## DEPARTMENT OF ENERGY

The FY 1994 budget request for the Office of Fossil Energy is $398.4, a decrease of $20 million, or 4.8 percent, relative to FY 1993 appropriations. Table 4 shows that substantial increases in funding for petroleum (29.6 percent) and natural gas R&D programs (25.3 percent) would be offset by a large decrease in coal R&D programs (25.1 percent). Significant parts of the oil and gas programs involve earth sciences R&D, whereas the coal program contains few earth sciences components.

The Office of Fossil Energy is refocusing its oil and gas R&D programs to include near-term and mid-term needs as well as its traditional long-range, high-risk elements. DOE's request for increased funding for petroleum R&D is a direct response to the alarming rate of premature abandonment of potentially productive domestic oil reservoirs. The proposed increase in natural gas R&D is consistent with the Administration's commitment to promote the use of clean domestic fuels. The Office of Fossil Energy is not requesting any further funding for oil shale research.

The FY 1994 budget request for Basic Energy Sciences is $802.0 million, a decrease of $58.7 million or 6.8 percent. The Engineering and Geosciences component of the Basic Energy Sciences budget is $37.9 million, which is little changed from FY 1993 appropriations.

The Energy Supply Research and Development budget request includes $24.0 million for geothermal energy research, an increase of 2.4 percent. Part of the geothermal budget is for earth sciences resource characterization and production research.

The Nuclear Waste Disposal program has significant earth sciences components. Funding for the program would remain nearly constant at $380 million. The FY 1994 budget request includes $261 million for site characterization at Yucca Mountain in Nevada.

DOE has made a major commitment to environmental restoration and waste management related to DOE facilities and disposal sites, and geotechnical considerations are an important part of that effort. The FY 1994 budget request for Environmental Restoration and Waste Management is $6,464 million, an increase of $967 million or 18 percent over FY 1993 appropriations. That program constitutes almost one-third of the entire DOE budget request.

## NASA

The FY 1994 budget request for NASA is $15.265 billion, an increase of $934.6 million or 6.5 percent over FY 1993 appropriations. Within the total budget request, funding for some programs is contingent upon the outcome of the redesign of the space station. NASA's R&D budget is $7,712 million, an increase of $623 million or 8.8 percent.

The Office of Space Science and Applications budget has been reorganized into three separate program offices, one of which is the Mission to Planet Earth. Solid-earth sciences R&D is a small component of many programs in the Mission to Planet Earth, and there is insufficient data to determine what proportion of the total funding is devoted to specific scientific disciplines. NASA's Mission to Planet Earth plays a major role in the U.S. Global Change Research Program.

The FY 1994 budget request for NASA's Mission to Planet Earth is $1,074.9 million, and increase of $137.0 million, or 14.6 percent, over the FY 1993 current plan. Table 5 shows that the Earth Observing System (EOS) and the EOS Data Information System account for nearly half of the budget for the Mission to Planet Earth, and both programs would receive large increases in FY 1994. The redesign of the EOS would reduce future costs by $2 billion.

The budget requests for other components of the Mission to Planet Earth are highly variable. Funding for Earth Probes would decrease by 2.1 percent to $97.3 million; the Airborne Program would increase by 21.7 percent to $25.2 million; Mission Operations and Data Analysis would increase by 8.9 percent to $160.8 million; and Payload and Instrument Development would decrease by 35.3 percent to $22.9 million.

## OTHER FEDERAL AGENCIES

Earth sciences R&D is conducted by other federal agencies, including the Environmental Protection Agency, Department of Agriculture, Department of Defense, Department of Commerce (particularly the National Oceanic and Atmospheric Administration, and the National Institute of Standards and Technology), and the Smithsonian Institution. It is relatively difficult, however, to identify and track the earth sciences R&D components of their budgets.

## INTERAGENCY FCCSET INITIATIVES

Interagency initiatives under the Federal Coordinating Council on Science, Engineering and Technology (FCCSET) play an increasingly important role in federal earth sciences R&D activities. The U.S. Global Change Research Program accounts for the vast majority of earth sciences R&D associated with the FCCSET initiatives. Earth sciences also play a small, but growing role in the High Performance Computing and Communications initiative and the Advanced Materials initiative.

The FY 1994 budget request for the U.S. Global Change Research Program is $1,476 million, including $1,013 million for NASA; $170 million for NSF; $98 million for DOE; $70 million for the Department of Commerce; $48 million for the Department of Agriculture; $34 million for the Department of the Interior; and $27 million for EPA. The President's budget request does not contain a detailed budget analysis of the FCCSET initiatives.

**Table 1.** National Science Foundation Geosciences Directorate (budget authority in millions of dollars)

| Program Element | FY 1992 Actual | FY 1993 Plan | FY 1994 Request | Change FY 1993-94 | |
|---|---|---|---|---|---|
| | | | | Amount | Percent |
| Earth Sciences | 75.9 | 75.8 | 89.7 | 13.9 | 18.4 |
| Atmospheric Sciences | 126.5 | 126.3 | 149.1 | 22.8 | 18.0 |
| Ocean Sciences | 177.5 | 177.7 | 209.8 | 32.1 | 18.1 |
| Science & Tech. Centers | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total, Geosciences | 380.8 | 379.8 | 448.5 | 68.8 | 18.1 |
| Total, R&RA | 1,871.1 | 1,859.0 | 2,204.8 | 345.8 | 18.6 |
| Total, NSF | 2,547.1 | 2,733.5 | 3,180.2 | 446.7 | 16.3 |

Source: NSF FY 1994 budget summary. All data in current dollars. FY 1993 current plan excludes the proposed FY 1993 stimulus package, which was blocked in the Senate, and excludes carryover of unobligated balances from 1992. R&RA = Research and Related Activities. Funding for existing science and technology centers is included in discipline subactivities. Total Geosciences excludes the Arctic Research Program, which is reported in U.S. Polar Programs beginning in FY 1994.

**Table 2.** NSF Earth Sciences Division of Geosciences Directorate (budget authority in millions of dollars)

| Program Element | FY 1992 Actual | FY 1993 Plan | FY 1994 Request | Change FY 1993-94 Amount | Change FY 1993-94 Percent |
|---|---|---|---|---|---|
| Earth Sciences Project Support | 49.7 | 50.0 | 57.3 | 7.3 | 14.5 |
| Continental Dynamics | 6.7 | 6.5 | 7.5 | 1.0 | 15.5 |
| Instrumentation and Facilities | 19.5 | 19.3 | 24.9 | 5.6 | 29.2 |
| Total, Earth Sciences | 75.9 | 75.8 | 89.7 | 13.9 | 18.4 |

Source: NSF FY 1994 budget summary. All data in current dollars.

**Table 3**. USGS Geologic Division (budget authority in millions of dollars

| Subactivity | FY 1992 Actual | FY 1993 Plan | FY 1994 Request | Change FY 1993-94 Amount | Change FY 1993-94 Percent |
|---|---|---|---|---|---|
| Geologic Hazards Surveys | 68.0 | 68.0 | 67.7 | -0.3 | -0.4 |
| Geologic Framework & Processes | 27.1 | 26.6 | 27.6 | 1.0 | 3.7 |
| Global Change & Climate History | 11.0 | 10.9 | 10.8 | -0.1 | -0.8 |
| Marine & Coastal Surveys | 36.7 | 35.7 | 35.6 | 0.0 | -0.1 |
| Mineral Resource Surveys | 50.3 | 48.3 | 47.9 | -0.4 | -0.8 |
| Energy Resource Surveys | 30.2 | 31.7 | 31.5 | -0.2 | -0.7 |
| Total, Geologic Division | 223.3 | 221.1 | 221.0 | 0.0 | 0.0 |
| Total, USGS Appropriations | 582.6 | 576.8 | 598.0 | 21.25 | 3.7 |

Source: USGS FY 1994 budget justification. All data in current dollars.

**Table 4.** DOE Office of Fossil Energy (budget authority in millions of dollars)

| Subactivity | FY 1992 Actual | FY 1993 Plan | FY 1994 Request | Change FY 1993-94 | |
|---|---|---|---|---|---|
| | | | | Amount | Percent |
| Coal R&D | 225.6 | 188.7 | 141.3 | -47.4 | -25.1 |
| Petroleum Technology | 56.5 | 62.4 | 80.9 | 18.5 | 29.6 |
| Natural Gas R&D | 63.2 | 80.5 | 100.9 | 20.4 | 25.3 |
| Other (includes offsets, etc.) | 95.2 | 86.8 | 75.3 | -11.5 | -13.2 |
| Total, Office of Fossil Energy | 440.5 | 418.4 | 398.4 | -20.0 | -4.8 |

Source: DOE Office of Fossil Energy proposed budget for FY 1994. All data in current dollars.

**Table 5.** NASA Mission to Planet Earth (budget authority in millions of dollars)

| Subactivity | FY 1993 Plan | FY 1994 Request | Change FY 1993-94 | |
|---|---|---|---|---|
| | | | Amount | Percent |
| Earth Observing System (EOS) | 263.8 | 322.7 | 58.9 | 22.3 |
| EOS Data Information System | 130.7 | 182.7 | 52.0 | 39.8 |
| Earth Probes | 99.4 | 97.3 | -2.1 | -2.1 |
| Payload & Instrument Development | 35.4 | 22.9 | -12.5 | -35.3 |
| Mission Operations & Data Analysis | 147.6 | 160.8 | 13.2 | 8.9 |
| Research and Analysis | 166.2 | 181.5 | 15.3 | 9.2 |
| Airborne Program | 20.7 | 25.2 | 4.5 | 21.7 |
| Space Communications | 4.0 | 3.0 | -1.0 | -25.0 |
| Information Systems | 0.0 | 11.8 | 11.8 | — |
| Research Operations Support70.1 | 67.0 | -3.1 | -4.4 | |
| Total, Mission to Planet Earth | 937.9 | 1,074.9 | 137.0 | 14.6 |

Source: NASA FY 1994 budget summary. All data in current dollars.

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# Water Resources Research in the FY 1994 Budget

*Robert C. Stiefel, UCOWR*

## INTRODUCTION

Water-related research is included in some way in most of the cabinet-level departments and independent agencies in the federal government, but this effort at examining the budget for water resources research is limited to four departments and agencies having a major responsibility for the resource. In the author's opinion these agencies account for over 95 percent of the Federal expenditures for water resources research. Water research in the marine environment and in the atmosphere is not considered, but is included in the Disciplinary Analysis on Atmospheric and Oceanic Sciences.

Funding for water resources research in the Federal FY 1994 budget that is considered in this analysis amounts to $764.8 million. This is an increase of four percent of the amount budgeted in FY1993. Most of the increase can be attributed to the government-wide water quality program.

## DEPARTMENT OF THE INTERIOR

The Department of Interior, through the Geological Survey (GS), in consultation with other federal and state agencies, will continue its implementation of the National Water Quality Assessment (NAWQA) program in 1994. The objective of the program is to describe the status and trends in the quality of a large, representative part of the Nation's surface water and groundwater resources and to provide a sound, scientific understanding of the primary natural and human factors affecting these conditions.

## Geological Survey

The 1994 request for Water Resources Investigations is $189.2 million. The request includes $52.5 million, an increase of $14.5 million over FY 1993, for the National Water Quality Assessment (NAWQA) program. Regional and national synthesis of key findings from study units are the foundation for comprehensive assessments of the nation's water quality. In 1994, the first 20 studies, which were begun in 1991, will continue intensive sampling which includes substantial growth in the amount of field and laboratory work. The second set of 20 study units will begin assessment activities. In addition, an increase of $0.5 million is requested to implement the provisions of OMB Memorandum 92-01, expanding USGS responsibilities in coordinating the water information activities of governmental and private sector organizations across the nation. Most other programs will be continued at 1993 levels with the exception of three programs: data collection and analysis, the National Water Information Clearinghouse, and the regional aquifer system analysis program. In 1994, no funds are requested for continuing the nuclear waste hydrology program.

Funding for the Water Resources Research Institutes will continue at the same level as last year, but research projects funded through the National Water Resources Research Grants program have been discontinued.

## The Bureau of Reclamation

The request for General Investigations is $12.7 million. General investigations funds are used to study water-related problems in the West and to identify and evaluate a broad range of alternative solutions. Most of the studies emphasize nonstructural, management, and conservation solutions to current water resources problems. They emphasize restoration and protection of water quality, fish and wildlife resources, and wetlands.

## Fish and Wildlife Service

The Fish and Wildlife Service conducts fish and wildlife research at the Service's 13 laboratories and operates Cooperative Research Units at 38 universities in 36 states. The Service conducts contaminants research on effects of new chemicals; wildlife research on nongame species, focusing on amphibians, reptiles and mammals; fisheries research to develop the capability to address the decline of fishery resources on large aquatic systems including interior and coastal rivers; and endangered species research to determine the status and ecological requirements of both endangered and candidate plants.

**Department of the Interior (in millions)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1993 Budget |
|---|---|---|---|
| U. S. Geological Survey | | | |
| National Water Resources Research System- | | | |
| Federal Program | $ 112.6 | $ 113.2 | $ 119.9 |
| Federal/State Coop Program | 63.3 | 63.5 | 63.5 |
| State Research Inst. | 8.0 | 6.2 | 5.8 |
| Total | $ 183.9 | $ 182.9 | $ 189.2 |
| Bureau of Reclamation | | | |
| General Investigations | $ 13.2 | $ 12.5 | $ 12.7 |
| Total | $ 13.2 | $ 12.5 | $ 12.7 |
| Fish & Wildlife Service | | | |
| Research & Development- | | | |
| Coop Research Units | $ 7.6 | $ 7.8 | $ 9.3 |
| Fisheries Research | 14.4 | 19.7 | 17.8 |
| Total | $ 27.0 | $ 27.5 | $ 27.1 |

## Environmental Protection Agency

The 1994 President's budget provides a total of $345.2 million for EPA's research and development program in water-related programs. This represents an increase of $24.5 million over the 1993 level.

The Water Quality Research program will develop and improve scientific data and technologies to help protect and enhance the designated uses of our nation's waters and related ecosystems, including research on coastal and marine waters, large lakes and rivers, wetlands, contaminated sediments, aquatic eco-criteria, nonpoint sources of pollution, habitat and bio-diversity, and wastewater and sludge.

Drinking Water Research will continue to focus on alternative drinking water disinfectants and initiate research in comparative risk modeling to identify the tradeoff between safe microbial levels and exposures to disinfection or disinfection by-products. The agency focuses ground water research relating to wellhead protection and underground injection control on four research areas: prevention of subsurface contamination, subsurface characterzation, subsurface transport and transformation, and subsurface microbial ecology. The agency, working with USDA and USGS, is studying the impact of agricultural chemicals and management practices on the quality of groundwater and surface water to examine the impact of alternative farming and watershed practices.

Hazardous Waste Research is conducted in several areas including: ecological risk assessment methods, groundwater, municipal solid waste, hazardous waste, surface cleanup, bioremediation, and international and domestic technology transfer. Field scale research will be initiated on groundwater and aquifer remediation, biofiltration of contaminated air and gasses, biotreatment of surface soils, soil in the vadose zone, sediments and sludge, and hazardous liquid wastes.

Scientists will focus on nonpoint sources of pollution to field test and validate models developed for predicting the leaching and runoff of pesticides and nutrients, mostly nitrates, applied over relatively large geographical areas. EPA will begin developing pollution prevention strategies and separation technologies for water in the chemical formulating and packaging industries under wastewater and sludge research.

The Superfund Research program provides the scientific and technical information necessary to resolve technical problems which inhibit the effective implementation of removal and remedial actions at Superfund sites. Research emphasis will continue on the development of innovative treatment technologies for use in cleanup actions under the Superfund Innovative Technology site program, and on the evaluation of naturally occurring or improved microorganisms (bioremediation) for their ability to degrade hazardous substance in a cost-effective and environmentally sound manner.

Leaking Underground Storage Tanks (LUST) research activities will address the detection and remediation of subsurface contamination caused by such tanks.

**Environmental Protection Agency (in millions)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Budget |
|---|---|---|---|
| Office of Research & Development | | | |
| Water Quality | $ 28.5 | $ 31.6 | $ 29.0 |
| Drinking Water | 21.7 | 20.0 | 19.7 |
| Hazardous Waste | 48.4 | 41.0 | 33.7 |
| Pesticides | 13.7 | 15.0 | 14.2 |
| Multi-Media | 110.4 | 118.3 | 163.0 |
| Toxics | 24.5 | 26.0 | 25.7 |
| Superfund | 65.1 | 68.0 | 59.1 |
| LUST | 0.8 | 0.8 | 0.8 |
| Total | $ 313.1 | $ 320.7 | $ 348.2 |

## Department of Agriculture

Funds are proposed to continue water quality programs funded in 1992 as part of a coordinated, governmentwide initiative. Much of the initiative is being targeted to nonpoint source pollution identified in plans developed by states under requirements of Section 319 of the Water Quality Act of 1987. Agriculture has been identified as a nonpoint source pollution contributor in many states. The major objective of the USDA water quality initiative is to provide farmers, ranchers, and other land managers with the information necessary to voluntarily adopt improved, environmentally sound management practices which do not sacrifice profitability.

The initiative will be evaluated based on water quality impacts expected on production factors, management practices, and costs of achieving water quality improvements.

The Agricultural Research Service conducts basic and applied research at federal laboratories to solve problems encountered by agricultural producers and consumers of farm and ranch products. Broad areas of emphasis include groundwater and other natural resource concerns of agriculture and support of USDA regulatory and technical assistance programs. ARS will continue a major program of water quality research in the Midwest and other production areas in cooperating with university researchers. As part of the governmentwide program of research on global change, ARS will target additional resources to better understand potential effects on hydrologic systems at point, watershed, and regional scales.

Federal-funded agricultural research conducted in partnership with the State Agricultural Experiment Stations (SAES) is administered through the Cooperative State Research Service. CSRS also operates competitive grant programs to fund scientifically meritorious research at universities, federal labs, private organizations and other institutions. Scientists and administrative personnel in CSRS work with the university system to coordinate planning and review programs and projects.

Special Research Grants fund research on designated problem areas at land-grant universities and other institutions. Research grants which target local issues or those which benefit limited specific business sectors are not included in the budget. Funding is $9 million for water quality research at universities and other institutions as part of the overall USDA Research Plan for Water Quality.

USDA conducts a coordinated water quality program that consists of four components: research, economic data collection and analysis, technology development and application, and project implementation. The research program includes a major project in the midwest that brings together research resources from USDA, the states and other Federal agencies to work on problems related to corn and soybean production.

In addition to the directed global change programs, a number of other USDA research and data collection programs provide significant inputs into better understanding how crops, water and soils will respond to climate changes. Included are soil and water research and survey programs, and plant and animal development programs to adapt to climate-related stresses.

**Department of Agriculture (in millions)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Budget |
|---|---|---|---|
| Agricultural Research Service | $ 50.7 | $ 51.6 | $ 52.3 |
| Coop Service State Research | $ 31.8 | $ 33.3 | $ 31.2 |
| Total | $ 82.5 | $ 84.9 | $ 83.5 |

## NATIONAL SCIENCE FOUNDATION

The Geosciences (GEO) Activity supports research in the atmospheric, geological and oceanographic sciences—advancing scientific knowledge of the Earth's environment and the ability to predict natural phenomena of economic interest such as weather, climate and earthquakes.

Earth Sciences research provides the fundamental understanding of Earth processes needed to resolve such practical problems as: the location and extraction of energy, water, and mineral resources; the human and environmental consequences of activities such as dam construction and disposal of chemical and nuclear wastes; and the management of water resources. The National Science Foundation is the primary source of Federal funding for academic basic research in geology, geophysics, geochemistry, hydrology and related disciplines.

Water-related research is also funded in some subactivities within the Engineering Activity. The Biological and Critical Systems and the Chemical and Thermal Systems Programs in Engineering are the areas primarily doing water resources related research.

**National Science Foundation (in millions)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Budget |
|---|---|---|---|
| Engineering Activity | | | |
| Biological/Critical Sys. | $ 6.4 | $ 7.4 | $ 6.6 |
| Chemical & Thermal Sys. | 9.8 | 11.4 | 10.8 |
| Geoscience Activity | | | |
| Earth Sciences | $ 75.9 | $ 88.1 | $ 89.7 |
| Total | $ 92.1 | $ 106.9 | $ 107.1 |

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# FY 1994 R&D in Biology

*Jennie Moehlmann, AIBS*

## HIGHLIGHT

- National Biological Survey Proposed. The Department of the Interior has proposed reorganizing the majority of its biological research programs into a single bureau, the National Biological Survey (NBS). By consolidating the biological research conducted throughout the Department from agencies such as the Fish and Wildlife Service, the National Park Service, and the Bureau of Land Management, the NBS is expected to improve research quality and productivity at a lesser cost. Research activities within the NBS will be conducted at four regional centers, twelve research laboratories, forty field stations, and over seventy cooperative research units. An estimated 950 researchers transferred to NBS will study population dynamics, physiology, behavior, ecology, habitats, biodiversity, ecosystem processes and functions, and national inventories of biota.

## DEPARTMENT OF THE INTERIOR

### National Biological Survey

Three weeks after President Clinton released the proposed 1994 budget, a revised request was sent to Congress for the establishment of a National Biological Survey within the Department of Interior, effective October 1, 1993. The free-standing bureau is expected to fill the vacuum that exists for broad-scale biological information and assessments of the nation's natural resources. Funding for the NBS is proposed at nearly $180 million, with most of the funds transferred from existing agencies such as the Fish and Wildlife Service (FWS). Of the total $179.4 million set aside for the NBS, $83.4 million is for three subactivities of research: Species Biology Research ($21.3 million), Population Dynamics Research ($14.7 million), and Ecosystems Research Activities ($47.4 million). The remaining $96 million in funding will support inventory and monitoring activities, technology development and transfer, the operation of Cooperative Research Units, and the general administration of NBS.

## Species Biology Research

Most of the funding for this subactivity is transferred from the Fish and Wildlife Service. Under this subactivity, wildlife research would receive $1.6 million; fisheries research, $7.2 million; endangered species research, $7.9 million; and contaminants research, $1.7 million. Smaller programs under $1 million make up the balance.

## Population Dynamics Research

The FWS will transfer the bulk of its population research to the NBS. Under this subactivity, wildlife research programs would be funded at $7.7 million; fisheries research, $3.7 million; endangered species research at $1 million; and contaminants research at $0.8 million. Research projects formerly assigned to the Bureau of Land Management constitute the remaining $1.6 million.

## Ecosystems Research Activities

As the largest research category within NBS, ecosystems research would receive $47.4 million under the new Clinton proposal. Again, research transfers from FWS totaling $25.8 million compile the bulk of the NBS ecosystem subactivity. Wildlife research of $5.6 million is proposed; $5.3 million would be available for fisheries research; contaminants research is set to receive $5.6 million; and technical development research will see $9.2 million under the NBS proposal. The National Park Service (NPS) transfers ecosystem research funding totaling $13.2 million to the NBS. NPS transfers are comprised of $3 million from global change research; $3 million from regional research; $1.9 million from park research; and $5.3 million from systemwide research. The Environmental Studies Program in the Minerals Management Service will transfer $4.5 million to the NBS. The remainder of the ecosystems research funding comes from four other Interior agencies.

## NATIONAL SCIENCE FOUNDATION

### Biological Sciences Activity

Funding for research in the Biological Sciences Directorate (BIO), which supports research in cellular and molecular biology, neural sciences, and environmental biology, received a proposed 7 percent boost to total $311.9 million for fiscal year 1994. BIO had requested an additional $20.1 million for research in the President's stimulus package. BIO research comprises 14 percent of the total research budget at NSF. Nearly 90 percent of the BIO budget will support individual investigator research.

### NSF Environmental Research Initiative

Within the BIO activity, an increase of $6.5 million is proposed for the environmental research initiative to total $70.1 million. NSF support will focus on integrated basic research to provide fundamental understanding of biosphere processes across major areas of science, and includes funding for the network of Long Term Ecological Research Sites. A new National Center for Ecological Synthesis and Analysis is proposed under BIO, with a $1 million budget. As part of the Environmental Research Initiative, this center would promote the study of complex ecological questions and serve as a site for the analysis of large ecological data sets.

### Biotechnology Initiative

Support for the biotechnology initiative, which includes over $4.3 billion throughout the federal government, includes NSF's proposed share for fiscal year 1994 of $216 million, up $10 million from last year. The BIO activity is scheduled to receive $119 million of this initiative, a $6 million increase. Biotechnology research throughout the BIO activity includes several areas: environmental remediation, structural biology, agricultural and marine biotechnology, bioprocessing, and bioelectronics and bionetworks. The BIO Directorate will take the lead in coordinating interdisciplinary research, with the remaining six NSF directorates sharing the remaining $97 million of the biotechnology budget for NSF.

## Federal Initiatives

The request emphasizes NSF support for two other federal initiatives. The BIO Directorate is also involved in the $1 billion high performance computing and communications (HPCC) initiative with a budget of $12.5 million as a part of the $305 million allocated to NSF. BIO's share of the global change initiative is $10.4 million (up from last year's request of $5 million). NSF's total for the fiscal year 1994 budget is over $170 million, or 11.3 percent of the $1.5 billion project.

## Polar Research Programs

The former US Antarctic Program has been retitled to the US Polar Research Programs due to its expanded role in funding polar research in both the Antarctic and Arctic. Arctic research was formerly funded from the Geosciences Activity. Total funding is $163.1 million. NSF manages the US program in the Antarctic and supports a multidisciplinary research program on weather and climate, earth sciences, glaciology, and other physical and biological characteristics of Antarctica and its surrounding seas. US Arctic research activities, which involves the Arctic Ocean and surrounding land masses, would receive $28.5 million in 1994, up $1.8 million, under the Clinton budget.

# DEPARTMENT OF ENERGY

## Biological and Environmental Research Program

DOE's Biological and Environmental Research program (BER) received a healthy increase in the Clinton budget to total $345 million, up 17 percent. Additional funding is provided for research relating to energy and environmental policy and for project definition studies of a dedicated isotope source. The BER program includes several areas of scientific research: analytical technology ($9.8 million), which involves development of advanced instrumentation and dosimetry terrestrial research activities; health effects research ($38.9 million), which investigates the health impact of radiation and energy related chemical exposure; general life sciences research ($109.6 million), involving fundamental cellular and molecular level studies including the Human Genome Project (a joint project with NIH); and medical applications studies ($38.9 million), developing techniques for the application of radiation and radionuclides for diagnosis and therapy.

## Global Change

A major element of the BER program is directed toward the global climate change research program ($90.3 million of DOE's total $98 million request). DOE focuses on reducing scientific uncertainties in the short term (within ten years). DOE studies the data necessary to quantify the role of clouds and oceans in climate change and enhance the climate model computing systems. DOE also continues to study the sources and sinks in the global carbon cycle and quantify impacts of climate change and increasing greenhouse gases on human and natural resources.

## Environmental Protection Agency

Although research funding for the EPA increases by 5.4 percent under the 1994 Clinton budget to a total of $535.9 million, most of the single-media research saw a slight decrease. The decreases in these categories represents a shift in EPA strategy toward greater support of cross-media research as reflected in the Multimedia budget which received a $53.5 million boost from the 1993 level to $217.6 million. The shift includes support for a high priority ecosystems initiative.

## Air

EPA research in this media is funded at $125.8 million under the President's proposal, a 5.8 percent decrease from 1993. This includes $27 million for global climate change research, which will focus on how climate changes will affect the terrestrial biosphere. EPA will also investigate the effects of criteria air pollutants on human health and the environment.

## Water Quality

Funded at $29.1 million under the Clinton budget (down $2 million), EPA research will include a multi-year research plan to develop a risk-based approach for wetland protection and management. Research will also be focused on coastal and marine waters, large lakes and rivers, contaminated sediments, aquatic ecocriteria, non-point sources of pollution, habitat/biodiversity, and wastewater and sludge.

### Drinking Water

Efforts in the Drinking Water category will support the agency's groundwater protection program. With a proposed budget of $19.7 million, EPA research will focus on nonpoint source pollution of groundwater.

### Pesticides

Research in the pesticide category, funded in the budget proposal at $14.2 million, down 0.8 percent from 1993, includes research on ecological risk assessment, watershed and aquifer contamination, and environmental releases of biotechnology products.

### Multimedia

With a new emphasis on cross-media research, EPA's multimedia category would receive $217.6 million. Research will emphasize ecological risk assessment, and would also support an environmental technology initiative to promote the transfer of environmentally desirable technologies.

## DEPARTMENT OF AGRICULTURE

### Agricultural Research Service

Spending for research programs at ARS will increase just $15.3 million to total $683 million under the Clinton budget plan. ARS conducts basic and applied research at federal laboratories with broad areas of emphasis, including efficient food and fiber production, groundwater and other natural resource concerns of agriculture, food safety, development of new products and uses for agricultural commodities. ARS research also supports several federal initiatives described elsewhere in this chapter.

### Cooperative State Research Service

Although the National Research Initiative (NRI) received a $32.7 million increase, total funding for CSRS is proposed to decrease by $2 million to $431 million. Much of the funding decrease comes from a $40 million cut in the Special CSRS Research Grants program which is administered by CSRS. The increase in the NRI budget will allow for more competitively awarded grants. Each of the six research categories of the NRI will receive increased funding under the Clinton plan (see table). Other CSRS programs include Sustainable Agriculture ($6.9 million proposed); Aquaculture Centers ($4.1 million); Supplemental and Alternative Crops ($3.0 million); and Rangeland Research Grants ($0.5 million).

### Special Research Grants

These grants fund research on designated problem areas at land-grant universities and other institutions. The proposed cut of nearly $40 million to a proposed $34.4 million is due to a shift to not funding research grants which target local issues or those which benefit limited specific business sectors. Research previously funded through these earmarked grants could be funded by the beneficiaries or through the peer-reviewed NRI. Funds are proposed for nine national priority special grant programs, including $1 million for biomass energy/biofuels research and $7 million for integrated pest management and biological control research.

### Forest Service

Research at the Forest Service will increase nearly $9 million to $194.4 million under the proposed Clinton budget. A new program in International Forestry is included in the Clinton budget. Budgeted at $37 million, this Forest Service program participates in a variety of international activities, including scientific research, technical assistance, and disaster assistance.

### Global Change

USDA agencies involved in the global change initiative include ARS ($10.1 million); CSRS ($12.9 million); and the Forest Service ($22.3 million). Agriculture and forestry concerns in the global change program focus on increases in atmospheric carbon dioxide, methane and nitrous oxides from forest land conversion, livestock and rice production, and the application of chemical nitrogen fertilizers. ARS will target additional resources to better understand potential effects on hydrologic systems at point, watershed and regional scales. Concern also focuses on levels of ultraviolet-B light and shifting temperature and moisture patterns that would have significant implications for agriculture and forestry.

## Advanced Manufacturing Initiative

ARS receives the bulk of the $50 million UDSA funds for this initiative, with a proposed budget of $42.5 million, up $7.5 million. ARS scientists will apply advanced research methods, such as bioconversion, enzyme engineering, and improved membrane separation to develop improved means to produce new products, including biofuels. Potential new uses include totally biodegradable plastics, biopesticides manufactured from starch, industrial lubricants and coatings, and natural additives for foods. Funds will support research at federal labs and competitive grants to university and other scientists and will support commercialization activities through USDA's Alternative Agricultural Research and Commercialization.

## Biotechnology Initiative

Total USDA money for the biotechnology initiative is set at $191 million. ARS research under the initiative is scheduled to receive $115.3 million, an increase of $1.5 million. Within the total funding for biotechnology, about $1.7 million is devoted to a program of research on biotechnology risk assessment to meet needs of regulatory and research agencies. CSRS dropped $20.5 million from its budget of last year to $66.7 million. Decreased biotechnology funding for CSRS reflects the elimination of earmarked special grants and facility projects partially offset by increased biotechnology investment proposed through the NRI. The Forest Service receives the remaining USDA share of $8.5 million.

## USDA Water Quality Initiative

USDA conducts a coordinated water quality program that consists of four components: research, economic data collection and analysis, technology development and application, and project implementation. The research program includes a major project in the Midwest that brings together research resources from USDA, the states, and other federal agencies to work on problems related to corn and soybean production. Funding for the ARS portion of the initiative is proposed at $52.3 million, and for CSRS, $31.2 million.

## Animal, Plant Health Information Service

The 1994 budget proposes funding of $8.2 million, up $3.6 million. The increase is for participation in the National Biological Control Program interagency initiative to conduct research and implement integrated pest and crop management systems.

## NATIONAL INSTITUTES OF HEALTH

As a whole, the National Institutes of Health received an increase of $329 million to $10.7 billion, a three percent increase from last year's funding level. However, the Administration has specified that $227 million will be added for AIDS research, and $216 million for breast cancer research, leaving funding for the rest of biomedical research below the 1993 funding level. Over the past few years, Congress has supported research at NIH with more funding than the President's request.

### Biotechnology Initiative

NIH receives the bulk of the $4.3 billion biotechnology initiative, with funding proposed at $3.4 billion. NIH's areas of research under this initiative includes manufacturing and bioprocessing, gene therapy, vaccine development, structural biology, food safety, and marine biotechnology.

### High Performance Computing

NIH is also part of the High Performance Computing Initiative, receiving $47 million of the $1 billion budget. NIH research includes biomedical imaging, developing algorithms and software in molecular biology (including comparison of genetic and protein sequence data), and developing prototype biomedical digital image libraries.

### Advanced Materials Initiative

Of the $2.1 billion Advanced Materials Initiative, $93 million is allocated to NIH. Research is conducted on the development of biomaterials to improve the suitability and durability of biomedical implants, such as artificial joints and organs.

Proposed funding for the National Science Foundation Biological Sciences Directorate for Fiscal Year 1994 (figures in $ millions)

| | FY92 (actual) | FY93 (current) | FY94 (request) |
|---|---|---|---|
| Molecular and Cellular Biosciences | | | |
| Biochemistry and Molecular Structure and Function | 33.6 | 33.2 | 37.4 |
| Cell Biology | 19.0 | 18.8 | 22.0 |
| Genetics and Nucleic Acids | 30.5 | 30.2 | 34.8 |
| Total | 83.1 | 82.1 | 94.1 |
| Integrative Biology and Neurosciences | | | |
| Physiology and Behavior | 30.2 | 29.9 | 34.3 |
| Neuroscience | 31.1 | 30.8 | 35.5 |
| Developmental Biology | 15.9 | 15.7 | 18.2 |
| Total | 77.2 | 76.4 | 88.0 |
| Environmental Biology | | | |
| Systematic and Population Biology | 21.2 | 22.6 | 25.9 |
| Ecological Studies | 26.3 | 25.1 | 29.4 |
| Long-term Projects | 25.1 | 24.0 | 27.8 |
| Total | 72.6 | 71.7 | 83.1 |
| Biological Instrumentation and Resources | | | |
| Instrumentation and Instrument Development | 14.0 | 13.9 | 14.9 |
| Special Projects | 27.4 | 27.2 | 31.9 |
| Total | 41.4 | 41.1 | 46.7 |
| Total, BIO | 274.4 | 271.3 | 311.9 |

Proposed funding for the United States Department of Agriculture for Fiscal Year 1994 (figures in $ millions)

| | FY92 (actual) | FY93 (current) | FY94 (request) |
|---|---|---|---|
| Agricultural Research Service | | | |
| Soil and Water Conservation | 81.9 | 82.4 | 83.5 |
| Plant Science | 244.8 | 241.5 | 244.7 |
| Animal Science | 112.5 | 113.6 | 115.1 |
| Human Nutrition | 49.9 | 49.7 | 50.1 |
| Commodity Conversion and Delivery | 127.4 | 129.4 | 137.1 |
| Integration of Agricultural Systems | 26.0 | 25.8 | 27.2 |
| Total, ARS Research Programs | 642.5 | 642.4 | 657.7 |
| Cooperative State Research Service | | | |
| State Agricultural Weather Information System | 0.4 | 0.4 | 0.0 |
| Federal Administration (direct appropriations) | 10.5 | 10.5 | 2.1 |
| Higher Education | 7.8 | 7.8 | 9.0 |
| 1890 Capacity Building Grants | 10.3 | 10.3 | 11.5 |
| Hatch Act Formula | 168.8 | 168.8 | 173.5 |
| 1890 Colleges and Tuskegee Formula | 27.4 | 27.4 | 28.2 |
| Cooperative Forestry Formula | 18.5 | 18.5 | 28.0 |
| Animal Health and Disease Formula | 5.6 | 5.6 | 0.0 |
| Total, CSRS Programs | 432.7 | 433.0 | 431.4 |
| National Research Initiative | | | |
| Natural Resources and Environment | 18.0 | 18.0 | 26.0 |
| Plant Systems | 40.0 | 40.0 | 45.2 |
| Animal Systems | 25.0 | 25.0 | 30.0 |
| Nutrition, Food Quality, and Health | 6.5 | 6.5 | 13.0 |
| Processes and New Products | 4.0 | 4.0 | 9.0 |
| Markets, Trade and Rural Development | 4.0 | 4.0 | 7.0 |
| Subtotal, NRI | 97.5 | 97.5 | 130.2 |
| Special Research Grants | 73.1 | 73.4 | 34.4 |
| Sustainable Agriculture | 6.7 | 6.7 | 6.9 |
| Aquaculture Centers | 4.0 | 4.0 | 4.1 |
| Supplemental and Alternative Crops | 1.2 | 1.2 | 3.0 |
| Critical Agricultural Materials Act | 0.4 | 0.4 | 0.0 |
| Rangeland Research Grants | 0.5 | 0.5 | 0.5 |
| Buildings and Facilities | 74.8 | 52.1 | 0.0 |
| Total, CSRS | 507.5 | 485.1 | 431.4 |

# 18

# Chemistry in the FY 1994 Budget

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## OVERVIEW

The FY 1994 budget request proposes increases in some areas of chemical science and engineering research and development, and decreases in others. The two major supporters of chemical R&D, which together provide approximately two-thirds of all support, are the National Institutes of Health and the National Science Foundation.

Research in the chemical sciences can be connected to needs of the chemical, materials, and biotechnology industries. Chemical research in areas associated with the Administration's focus on technology should benefit in the long term. Funding for the chemical sciences tied to the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) initiatives is also expected to grow.

- The proposed budget for the National Institutes of Health (NIH) keeps pace with inflation, although support for basic research activities would decrease.
- Funding for chemistry at the National Science Foundation (NSF) would receive a 14.8 percent increase.
- Department of Energy funding for chemistry would increase.
- Funding for chemistry from the Defense Research Offices would remain flat, with the exception of the Army.
- At the National Institute of Standards and Technology,

the Chemical Science and Technology program is scheduled to grow.

- Support for chemical science research and development at the Environmental Protection Agency would be reduced in all areas except for Multimedia Research, which would receive a small increase.
- The U.S. Department of Agriculture would increase support for chemistry-related programs.

## NATIONAL INSTITUTES OF HEALTH

President Clinton has proposed $10.7 billion for the National Institutes of Health FY 1994 budget. The $329 million, or 3.2 percent, increase over FY 1993 manages to keep pace with inflation, which is projected at 3.1 percent for the budget year. Within the inflationary increase, funding for basic research is slated for a 1.6 percent increase from $5.68 billion in FY 1993 to $5.77 billion in FY 1994. Adjusting the increase for the Biomedical Research and Development Price Index (BRDPI), projected to be near 5.1 percent during FY 1994, the basic research budget will actually decrease 3.5 percent below the FY 1993 level.

The proposed budget would keep funding for Research Project Grants (RPGs) essentially flat, increasing 0.4 percent to $5.68 billion. Based on an estimated 21.6 percent success rate, the budget would allow for an estimated 23,196 grants to be funded, 386 fewer grants than in FY 1993. Similarly, the number of new and competing grants will also decrease 2.3 percent from the FY 1993 level to 5,463. The average grant size will increase 2.2 percent over the FY 1993 level. Research training programs are scheduled to increase $6 million to $355 million in FY 1994.

Since research in the chemical sciences derives its funding from many different institutes, opportunities for funding must be gauged by the following trends within the specific institutes that have traditionally supported chemistry-related studies, or scientists in academic chemistry and biochemistry departments. While increases in various institutes might indicate increased opportunities for chemists, recent history indicates that this will not entirely translate into increased funding. The discord between institute growth and support for the chemical sciences may be especially harsh this year due to extensive presidential earmarking. Chemical scientists working in these areas may be able to take advantage of these opportunities; however, many of the increases are targeted to research beyond the scope of the chemical sciences.

By far the greatest support for the chemical sciences comes from the **National Institute of General Medical Sciences** (NIGMS). In recent years, nearly 70 percent of all research monies awarded to chemistry departments and slightly more than 45 percent awarded to biochemistry departments came from this Institute. Overall NIGMS would increase 0.1 percent from FY1993 to $833 million, 4 percent less than BRDPI. Within NIGMS:

- The **Biophysics and Physiological Sciences** program, which funds a large number of grants to academic chemistry departments, is slated to rise 4.9 percent to $185.2 million. This program supports considerable analytical chemistry research, as well as research on biophysical chemistry of large molecules.
- The **Cellular and Molecular Basis of Diseases** program, which contains considerable opportunities for chemists to study the molecular-level biochemistry of cellular processes, would receive a 0.4 percent increase to $230.3 million.
- **The Pharmacological Sciences** program is scheduled to decrease 2 percent to $120.7 million. Basic chemical studies of all kinds, with particular attention to organic and inorganic synthesis, are funded by this program.
- The **Genetics** program also is slated to decrease, dropping 2.6 percent to $221.3 million.

The second largest supporter of chemistry at NIH, the **National Cancer Institute** (NCI), provides nearly 15 percent of all research funds awarded to chemistry and biochemistry departments. NCI is slated for an 8.1 percent increase, one of the largest increases at NIH. As stated earlier, this may not translate into increased funding for the chemical sciences. Most of this increase is targeted for specific health issues, such as breast cancer and other clinical investigations.

The **National Institute of Allergies and Infectious Diseases** (NIAID), which also is a major supporter of research in the chemical sciences, has received a proposed budget increase of 8.8 percent. Funding for the chemical sciences at NIAID has kept pace with the rapid growth of the Institute.

Other institutes providing considerable support for the chemical sciences in the past (about $10 million a year each) include the following: **National Heart, Lung, and Blood Institute would decrease 1.3 percent, the National Institute of Diabetes and Digestive and Kidney Diseases** would be cut 0.6 percent, and the **National Institute**

**of Environmental Health Safety** would rise 4.0 percent over FY 1993 levels. The **National Center for Research Resources** would receive a 4.9 percent increase in FY 1994, provided President Clinton's budget is enacted. Within NCRR the **Shared Instrumentation** program administered by the **Biomedical Research Technology** program is slated to increase 8.0 percent over FY 1993 levels to $62.5 million; however, this level of funding is still nearly $10 million lower than FY 1991 levels.

## THE NATIONAL SCIENCE FOUNDATION

NSF's FY 1994 budget request contains a revised FY 1993 baseline, which includes the original FY 1993 appropriation of $2.73 billion and a proposed FY 1993 supplemental of $206.6 million. The supplemental contained an additional $10.0 million for the Chemistry Division, and an $8.9 million increase for the Materials Research Division. However, Congress did not enact the supplemental. As a result, there is some confusion over NSF's FY 1994 budget request. It is unclear how incremental increases to line items identified within the FY 1994 budget request will be affected by NSF's current FY 1993 budget situation.

Within the request, programs supporting chemistry at NSF would increase 14.8 percent overall from the original FY 1993 appropriation. Figures for specific program increases provided in this section reflect the dollar amount proposed by NSF in its FY 1994 budget request. However, these figures do not account for funds contained within the supplemental in support of these programs, since NSF did not provide a programmatic breakdown of how the supplemental would have been spent.

**Table 1.** Programs Supporting Chemistry at the National Science Foundation (budget authority in millions)

| | FY 1992 Actual | FY 1993 Est. | FY 1994 Request | Percent Change FY 1993–94 |
|---|---|---|---|---|
| **Chemistry Division** | | | | |
| Research Project Support | 95.49 | 95.63 | 111.50 | 16.6 |
| Instrumentation & Infrastructure | 16.62 | 16.59 | 19.39 | 16.9 |
| **Subtotal, Chemistry** | 112.11 | 112.22 | 130.89 | 16.6 |
| **Material Research** | | | | |
| Materials Research Project Support | 77.73 | 82.82 | 92.41 | 11.6 |
| Materials Research Centers & Groups | 48.07 | 49.45 | 56.44 | 14.1 |
| National Facilities & Instrumentation | 17.74 | 18.40 | 22.10 | 20.1 |
| **Subtotal, Materials Research** | 143.54 | 150.67 | 170.95 | 13.4 |
| **TOTAL** | 255.65 | 262.89 | 301.84 | 14.8 |

Source: National Science Foundation

For FY1994, the **Chemistry Division** would increase 16.6 percent over the original FY 1993 appropriation, for a total budget of $130.9 million. The Division's request strongly emphasizes support for the governmentwide FCCSET initiatives, as well as one NSF-specific initiative. In addition, the Division would enhance funding for chemical sciences instrumentation and facilities, as well as its educational activities, such as the **Research Experiences for Undergraduates** program and postdoctoral fellowships in interdisciplinary areas.

- Chemistry Division support for the FCCSET initiatives totals $5.1 million, reflecting 59 percent of the Division's proposed increase. Programs specifically mentioned for increases include the **Advanced Materials and Processing** (+$1.2 million), **High Performance Computing and Communications** (+$1.2 million), and **Biotechnology** (+$0.6 million) initiatives. In addition, the Division would participate in the **Advanced Manufacturing** initiative at a level of $0.4 million.
- An additional $2.24 million would expand the Chemistry Division's program in "environmentally benign chemical manufacturing," part of the Foundation's initiative in **Multidisciplinary Research on the Environment**. Receiving over 25 percent of the Division's total proposed increase, this program would enhance funding for research on new catalytic processes to reduce waste production and new separation and detection methods.
- Support for the Chemistry Division's **Instrumentation and Infrastructure** programs would rise $2.5 million. This increase would include $1.0 million for instrumentation and facilities in the chemical sciences, and $1.5 million to strengthen the Division's educational infrastructure.

The **Materials Research Division** budget is slated to rise 13.4 percent over the original FY 1993 appropriation, for a total FY 1994 budget of $170.95 million. Approximately 75 percent of the requested increase would support the FCCSET initiatives. Specifically, the Materials Research Division plays a lead role in the **Advanced Materials and Processing** initiative, and would enhance its funding of these activities.

- **Materials Research Project Support** would increase by $4.7 million, reflecting 41 percent of the total proposed increase.
- Resources to establish new **Materials Research Centers and Groups** would rise $3.5 million.

- **National Facilities and Instrumentation** would increase $3.2 million. These funds would provide for the establishment of a national nanofabrication users facility network, as well as for the acquisition of major instrumentation for materials research.

## DEPARTMENT OF ENERGY

Overall, the budget for chemistry-related research within the Department of Energy would increase 6.0 percent to an estimated $283.8 million. Within **Basic Energy Sciences** (BES), emphasis continues on the FCCSET initiatives in the FY1994 budget. Increases for the **Advanced Materials and Processing** and for **Biotechnology Initiatives** are spread across BES programs.

Within BES:

- A 4 percent increase to $110.4 million is proposed for **Chemical Sciences Research.** This $4.6 million increase would be targeted for the Advanced Materials and Processing initiative, for a $7.5 million total in FY1994. The budget includes $17.0 million for Biotechnology Research, which is about the same as FY 1993. **Facilities Operations** would be increased $2.0 million to $58.6 million.
- **Materials Sciences Research** is slated for a 5 percent increase to $143.1 million in FY 1994. This increase is primarily intended for support to the Advanced Materials and Processing initiative. Facilities Operations would be funded at $133.9 million, with support for the **Advanced Neutron Source** being presented as a separate item.

Under **Biological and Environmental Research**, construction of the **Environmental and Molecular Sciences Laboratory** (formerly funded under Environmental Restoration and Waste Management) would continue at $33.0 million.

**Fossil Energy R&D** would take less of a cut than proposed by recent Administrations, down 5 percent below FY1993. Within Fossil, **Advanced Coal Research** subprograms would decline 19 percent to $31 million. Included in this total is **University Coal Research**, which remains essentially level in current dollars at close to $6 million.

## DEPARTMENT OF DEFENSE

Funding for basic ("6.1" category) research in the Department of Defense (DOD) is expected to decrease 5.1 percent to $1.26 billion in FY

1994. Within this total, support for extramural chemistry from the defense research offices is estimated to increase 3.8 percent to $40.6 million. Only the Army Research Office expects to receive an increase that is above inflation, $1.1 million, for a total of $10.4 million (this total includes the University Research Initiative, historically black colleges, fellowships, and supplements for student support). Numbers may be augmented as awards come from other DOD programs and accounts.

For FY1994, the Navy is planning two enhancements in the base program. Under **Polymer Chemistry**, research would be supported to understand how to characterize polymer surfaces and to synthesize polymers with controlled surface properties. Research in **Polymer Gels and Electrostrictive Polymers** would develop the science base for the design, synthesis, and characterization of multifunctional polymers. An interdisciplinary Navy effort would be undertaken to understand mechanism and kinetics of organisms involved in **Biocorrosion** (joint with **Material Sciences and Biology**). The Air Force has plans for new awards in corrosion and organic superconductors.

Army medical research accounts provide funds for medicinal chemistry, about 50 to 60 percent of which goes to chemistry departments, the remainder to research institutions. Although an official FY 1994 figure is not available, support is estimated to be below the FY 1993 level of about $15.5 million.

## NATIONAL INSTITUTES OF STANDARDS AND TECHNOLOGY

In line with the increased emphasis on technology, the Administration's proposed FY1994 budget for the National Institutes of Standards and Technology would increase the **Chemical Science and Technology** program $3.8 million to $23.1 million. This increase includes $3.0 million for the **Biotechnology and Chemical Processing Initiative** which would provide new techniques, tools, and processes to enhance industry's productivity and reduce chemical waste.

## ENVIRONMENTAL PROTECTION AGENCY

Traditionally, the purpose of the Environmental Protection Agency's (EPA) research and development programs has been to support the agency's regulation of air and water quality, hazardous waste management, pesticides, toxic substances, and radiation. In recent years, EPA's research program has focused more on predicting and preventing potential risks. The FY1994 EPA budget for Research and Development includes an increase of $27.5 million for the conduct of R&D, and increase of 5.4 percent, for a total budget of $535.9 million.

Owing to the regulatory nature of EPA's mission, almost all its R&D activities entail some form of chemistry support. This year EPA is continuing to divide its R&D funds by environmental issues. This classification makes the determination of the Agency's planned commitment to chemistry research difficult. This report therefore focuses on those issues, spread across various media, which appear to contain considerable chemical science and engineering components.

**Multimedia Research** is the only area of EPA's R&D budget that does not propose a reduction in funds in FY 1994. Its budget is slated to increase $53.5 million in FY 1994, roughly half of which represents funds cut from other media-specific research programs. Multimedia programs of interest to chemical scientists and engineers include:

- The **Ecological Risk Assessments** program would grow 84 percent to $19 million to support integration of EPA's fragmented ecological risk assessment programs.
- The **Environmental Monitoring and Assessment Program** (EMAP) will increase 6.1 percent to $2.4 million. The program will continue to fund the site-specific pilot projects that are used to compile data, focusing on biological indicators; will continue support for university-based research into ecological processes; and will continue EMAP testing.
- Multimedia's **Pollution Prevention** program would rise 1.2 percent to $9.7 million, investigating risk reduction options through source reduction, elimination of cross-media pollutant transfer, and incorporation of these solutions into new multimedia regulations.
- The **Lead and Other Heavy Metals** research program is slated to rise 31.2 percent to $4.2 million, to fund the development of technologies to improve identification and abatement of lead in paint, dust, and soil.

## U.S. DEPARTMENT OF AGRICULTURE

Within the **Cooperative State Research Service** in the U.S. Department of Agriculture, the competitively awarded **National Research Initiative** (NRI) would increase 33.5 percent to $130.2 million in FY 1994. Included in NRI would be $13 million to continue mapping important crop plant genes. Also, an estimated $7.0 million would be available to develop biomass fuels and new uses for agricultural products.

Funding under the **Agricultural Research Service** for the eight in-house laboratories performing chemical research would increase 3.2 percent in FY 1994 to $211.8 million, still below FY 1992 support. Funding continues on chemical wing modernization at Albany, California ($4.7 million) and New Orleans ($3.6 million).

# 19

# Behavioral and Social Research in the FY 1994 Budget

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Research in the behavioral and social sciences can be found in federal agencies ranging from the Department of Health and Human Services to the Department of Defense. Highlights of the FY 1994 budget proposal for relevant programs are represented in Tables 19.1-19.4 in this chapter and the brief analyses of selected programs that follow.

## DEPARTMENT OF HEALTH AND HUMAN SERVICES

### National Institutes of Health (NIH)

Most of the National Institutes of Health (NIH) research institutes support or conduct research in the behavioral and social sciences including basic behavioral research, behavioral epidemiology, and studies of educational intervention and behavior change. NIH estimates FY 1994 expenditures of $826.9 million on "health and behavior" research, toward the goal of gaining a better understanding of: biobehavioral mechanisms or processes through which behavior influences, or is influenced by, health and illness; the identification and distribution of psychosocial risk factors in populations; the development, maintenance, and change of health-related behaviors; and behavioral and social interventions to prevent and treat illness or to promote health. The NIH also provides strong support for behavioral and social science in seeking a better understanding of the child development and aging processes.

The President's FY1994 budget request for NIH is $10.7 billion, an overall increase of 3.2 percent, which is below the rate of biomedical R&D inflation. The President's plan calls for cutting nine of the NIH's 16 research institutes by a total of $52 million, with four others receiving an increase of approximately 1 percent. The 1994 NIH request is divided into three areas—Critical Technologies, Intellectual Capital, and Critical Health Needs—a framework taken directly from NIH's draft strategic plan. The select areas of the NIH budget in which the President recommends an increase include women's health, HIV/AIDS, breast cancer, minority health, high-performance computing, tuberculosis, and human genome research. There should be opportunities for the behavioral and social sciences in at least one or two of these areas.

The National Institute on Aging (NIA) and the National Institute of Child Health and Human Development (NICHD) are major sources of support for behavioral and social science research. NIA, which received a 23 percent funding boost two years ago, would face a decrease of just over 1 percent in the FY1994 budget. Within NICHD certain programs would receive new funding for specific initiatives, for example, an extra $3.0 million would go to the Demographic and Behavioral Sciences Branch to fund two surveys of sexual behavior—one adult survey and one adolescent survey.

With the passage of reorganizing legislation in 1992, the research and service missions of the former Alcohol, Drug Abuse and Mental Health Administration (ADAMHA) were separated, with the research agencies—the National Institute of Mental Health (NIMH), National Institute on Drug Abuse (NIDA), and National Institute on Alcohol Abuse and Alcoholism (NIAAA)—transferring to the National Institutes of Health. The treatment and prevention missions of the former ADAMHA agencies were organized under new names, and became part of the Substance Abuse and Mental Health Services Administration (SAMHSA). The return to the NIH system by mental health and substance abuse research programs has resulted in a loss for two of them—NIMH and NIAAA—of one to two percent in their research bottom line, with NIDA doing the best with a 0.9 percent increase. See Tables 19.2 & 19.3 for details of interest to behavioral and social scientists in the FY 1994 budget proposal for NIH.

The addition of research dollars spent by NIMH, NIDA, and characterizing 8 percent of their research spending as an investment in health and behavior research—twice what they reported in FY1993. The congressionally mandated plan for proportionately increasing health and behavior research funding at NIH was delivered to Congress in November 1991, but the implementation plan for achieving the goals set out by the plan has not yet been submitted. See Table 19.1 for NIH's latest estimates on health and behavior research spending.

## NATIONAL SCIENCE FOUNDATION (NSF)

The National Science Foundation's (NSF) FY 1993 appropriation was 6.3 percent above their FY 1992 budget, but spending directives from Congress and recommendations from the Commission on the Future of NSF resulted in a FY 1993 decrease for the core research programs—including those supporting behavioral and social science research. The FY 1994 request would make up for this decrease, and if approved, would increase funding for the recently created Directorate for Social, Behavioral and Economic Sciences (SBE) by over 19 percent. This larger-than-average recommended increase came about because the Administration's stimulus package, with $207 million for NSF, failed to gain congressional approval. Since NSF's FY 1994 request was based on the assumption that they would receive this money for FY 1993, their FY 1994 request averaged 16 percent over the actual FY 1993 estimated budget.

SBE's FY 1994 request of $106.9 million represents a $17.4 million increase over their FY 1993 appropriation. Two million dollars would go to restore funds for the core research programs, which were reorganized into "clusters" in FY 1993 (see Table 19.4). Social science research would receive $0.4 million in a new NSF strategic initiative on Civil Infrastructure.

Also included is $1.1 million to support SBE's increased participation in three initiatives coordinated by the Federal Coordinating Council for Science, Engineering and Technology (FCCSET). High Performance Computing and Communications would receive $0.35 million for research to understand and improve people's abilities to process complex information. Research on effective models for managing technological innovation would be funded out of the $0.4 million increase in Advanced Manufacturing. And finally, $0.35 million in Math and Science Education would go to research on urban education (in collaboration with NSF's Urban Systemic Initiative).

The Intelligent Systems Initiative (formerly the Cognitive Science Initiative) would receive $1.46 million. This is a small increase over its current $1 million budget. This interdisciplinary initiative is being coordinated with the Directorate for Computer and Information Science and Engineering.

Behavioral and social science research is also supported through other NSF Directorates—Biological Science (BS), and Education and

Human Resources (EHR). EHR is discussed elsewhere in this volume. Before the former Directorate of Biological, Behavioral and Social Sciences was reorganized, the SBE research programs were housed together with the BS programs in Physiology and Behavior and Neuroscience. Funds for these two BS programs decreased in FY1993, as did money for other NSF core research programs. The FY 1994 request of $34.3 million for Physiology and Behavior is a 14.8 percent increase over FY1993. This includes $2.2 million to enhance collaborative research on the behavioral mechanisms of ecological phenomena and to augment award sizes. The $35.5 million FY1994 request for Neuroscience is 15 percent above the FY 1993 budget for this program. See Table 19.4.

## DEPARTMENT OF DEFENSE (DOD)

Behavioral and social science research funded by the Department of Defense (DOD) is designed to support the needs of the services. Basic research is linked to applied research and development in a direct way that is reflected in the DOD classification of its Research, Development, Test and Evaluation (RDT&E) budget. 6.1 is research, 6.2 exploratory development, 6.3 advanced development, and on up to 6.6 which is actual systems development. Behavioral and social science research is conducted in the 6.1, 6.2, and 6.3 programs.

The work supported ranges from research to improve the selection and assignment of personnel, to the training and maintenance of skills, and the design of the human-machine interface to ensure efficient and safe operation of complex hardware.

The Office of Naval Research's (ONR) FY 1994 request for the Cognitive and Neural Sciences, within the Life Sciences Directorate, is $17.5 million, which would be a $1 million increase over FY 1993. This would support research in cognitive science, perceptual science, and stress and performance. ONR also participates in the University Research Initiative (URI) program and the Manpower, Personnel and Training Research and Development Program. The Manpower program is an applied research program concerned with advanced instructional technology, and personnel testing, assignment and measurement. The URI initiative is a special program of basic research designed to study how coordination is achieved and maintained by hierarchical decision-making teams in stressful environments.

The total FY 1994 request for the Air Force Office of Scientific Research (AFOSR) is $241.3 million, a 2.3 percent increase in 6.1 funds. Of that, $48.1 million would go to AFOSR's Directorate of Life and Environmental Sciences, which supports basic research in the Air Force laboratories through extramural grants. The Human Performance Project in this Directorate supports most of the behavioral research; its FY 1994 request is $11.4 million, which would be a $1.3 million increase over the FY 1993 budget.

The Army Research Institute for the Behavioral and Social Sciences (ARI) funds basic (6.1), exploratory development (6.2), and advanced development (6.3) programs. The FY 1993 request of $3.9 million for basic research in ARI would fund research on human performance, individual and group performance processes, and a special project in human chronopsychology. Of ARI's FY 1994 request, $23.9 million would go to its Manpower and Personnel Research and Development program and its Training Systems Research and Development program.

## THE DEPARTMENT OF EDUCATION

Research and related projects within the Department of Education are housed primarily within the Office of Education Research and Improvement (OERI). Growth within the OERI account continues to emphasize statistics, assessment and improvement programs with lesser rates of growth in the pure research programs. Significant increases in research funding throughout the Department of Education (DoE) are proposed as part of the Administration's proposal to increase public "investment" in lifelong learning, and are contingent upon either the enactment of a deficit reduction proposal or an increase in the caps on spending that were instituted through the Budget Enforcement Act of 1990. It is also important to note that this year's appropriation for OERI may be affected by the failure of Congress to reauthorize the agency last year. It is not uncommon for Congress to level-fund agencies that have not been reauthorized.

Research within OERI fares better than much of the Department of Education under the Administration's plan. If the investment increment is approved, research at OERI would be funded at an FY 1994 level of $90.8 million—an increase of 22.7 percent over FY 1993. Without the additional support from the investment proposal the OERI research line would receive a 2.7 percent inflation increase, to $76.0 million, in FY 1994.

The principal components of the OERI research account are the Research Centers, the Regional Labs, and Field Initiated Studies. The 18 mission-oriented Research Centers, which conduct long-term R&D in areas of national concern and disseminate their findings and products nationally, are housed at universities around the country. They would receive a 6.6 percent increase to $29.3 million. The Regional Laboratories, which identify the education R&D needs in a specified region of the country and help meet those needs through applied research, development, dissemination, and technical assistance, are recommended for a 5.2 percent increase to $38.0. The small Field Initiated Studies account, which supports the peer-reviewed work of independent scholars, would more than triple from $0.958 million to $3.0 million.

New research activities within OERI would include $4.0 million for research on the disadvantaged, which would continue the work of the expiring Center on Disadvantaged Youth; $2.0 million for research on assessment, and $2.5 million for data analysis/research synthesis.

For the National Board for Professional Teaching Standards federal funds are recommended only for its R&D activities, which would include an inflation increase in FY 1994 to bring it to $4.9 million.

Within the Office of Vocational and Adult Education (OVAE) the primary research instrument is the National Center for Research on Vocational Education (NCRVE). In FY 1994, the center would be frozen at the FY 1993 and FY 1992 level of $6.0 million, a figure much larger than any of the OERI research centers, which average about $1.6 million. Discretionary research in OVAE would receive a noteworthy increase from $0.2 million in FY 1993 to $2.4 million in the FY 1994 request.

Research on methods to improve instruction and services for limited English proficient students within the Office of Bilingual and Immigrant Education would increase from a nominal $0.6 million to $1.5 million.

International education focusing on faculty research abroad and doctoral dissertation research relating to less commonly taught foreign languages would receive $2.4 million, a 2 percent decrease from FY 1993.

Federal support to assist in education for individuals with disabilities through Special Education programs includes a variety of research activities in Special Purpose Funds. These programs strive to improve education for children and youth with disabilities. These programs would be frozen in FY 1994 at $33.8 million.

Rehabilitation Services and Disability Research programs include the National Institute on Disability and Rehabilitation Research (NIDRR). NIDRR funds rehabilitation research and training centers, and rehabilitation engineering research centers as well as field initiated studies and demonstrations projects. The FY 1994 request is for $50 million for research in this area, a slight decrease from the FY 1993 level of $51.5 million. Total funding for NIDRR would be frozen at $67.2 million.

**Table 19-1.** NIH Health & Behavior Research (dollars in millions)

| | FY 1992 actual | FY 1993 estimate | FY 1994 budget | % change FY 1993-94 |
|---|---|---|---|---|
| NCI | $ 80.2 | $ 85.7 | $ 90.0 | 5.0 |
| NHLBI | 67.9 | 75.3 | 79.0 | 4.9 |
| NIDR | 6.3 | 6.2 | 6.4 | 3.2 |
| NIDDK | 16.6 | 17.1 | 16.7 | -2.3 |
| NINDS | 40.4 | 41.7 | 40.7 | -2.4 |
| NIAID | 6.3 | 6.4 | 6.7 | 4.7 |
| NIGMS | 4.3 | 4.4 | 4.4 | 0.0 |
| NICHD | 55.7 | 56.0 | 58.0 | 3.6 |
| NEI | 6.5 | 6.7 | 6.5 | -3.0 |
| NIEHS | 7.0 | 7.1 | 7.2 | 1.4 |
| NIA | 61.0 | 62.9 | 61.6 | -2.1 |
| NIAMS | 6.6 | 6.8 | 6.7 | -1.5 |
| NIDCD | 7.7 | 8.0 | 8.0 | 0.0 |
| NCRR | 23.0 | 22.9 | 24.0 | 4.8 |
| NIAAA | 33.0 | 34.5 | 35.0 | 1.4 |
| NIMH | 163.4 | 170.1 | 168.3 | -1.1 |
| NIDA | 168.5 | 175.8 | 177.3 | 0.9 |
| NCNR | 20.4 | 22.0 | 22.0 | 0.0 |
| OD | 0 | 0 | 0 | 0.0 |
| FIC | 0.7 | 0.7 | 1.0 | 42.9 |
| NLM | 6.5 | 6.5 | 6.3 | -3.1 |
| **Total** | **$782.0** | **$817.1** | **$825.9** | **1.1** |

**Table 19-2.** National Institutes of Health (budget authority in millions, by mechanism)

| | FY 1992 actual | FY 1993 estimate | FY 1994 budget | % change FY 1993-94 |
|---|---|---|---|---|
| **National Institute of Mental Health (NIMH)** | | | | |
| Research Project Grants | $282.2 | $287.3 | $279.0 | -2.9 |
| Research Centers | 63.8 | 64.2 | 67.5 | 5.1 |
| Other Research | 46.0 | 55.2 | 55.4 | 0.4 |
| Total Research Grants | 392.0 | 406.7 | 401.9 | -1.2 |
| **National Institute on Drug Abuse (NIDA)** | | | | |
| Research Project Grants | $195.9 | $205.1 | $207.0 | 0.9 |
| Research Centers | 34.0 | 36.9 | 36.9 | 0.0 |
| Other Research | 59.8 | 53.6 | 54.2 | 1.1 |
| Total Research Grants | 289.7 | 295.5 | 298.1 | 0.9 |
| **National Institute on Alcoholism and Alcohol Abuse (NIAAA)** | | | | |
| Research Project Grants | $98.4 | $96.9 | $94.4 | -2.6 |
| Research Centers | 16.8 | 17.1 | 17.1 | 0.0 |
| Other Research | 13.3 | 17.1 | 17.1 | 0.0 |
| Total Research Grants | 128.5 | 131.1 | 128.5 | -2.0 |
| **National Institute on Aging (NIA)** | | | | |
| Research Project Grants | $230.9 | $241.2 | $238.0 | -1.3 |
| Research Centers | 46.8 | 50.1 | 49.9 | -0.4 |
| Other Research | 13.7 | 13.5 | 13.4 | -0.7 |
| Total Research Grants | 291.4 | 304.8 | 301.2 | -1.2 |
| **National Center for Nursing Research (NCNR),** | | | | |
| Total Research Grants | 35.3 | 38.0 | 38.4 | 1.1 |
| **National Institute of Dental Research (NIDR),** | | | | |
| Total Research Grants | 106.6 | 107.9 | 109.5 | 1.5 |

**Table 19-3.** National Institutes of Health (budget authority in millions, by program)

| | FY 1992 actual | FY 1993 estimate | FY 1994 budget | % change FY 1993-94 |
|---|---|---|---|---|
| **National Institute of Child Health and Human Development (NICHD)** | | | | |
| Center on Research for Mothers & Children | 272.6 | 278.1 | 283.0 | 1.8 |
| Human Learning and Behavior Branch | 40.9 | 41.7 | 41.2 | -1.2 |
| Center for Population Research | 141.7 | 139.4 | 146.0 | 4.7 |
| Demographic and Behavioral Science Branch | 30.9 | 30.6 | 33.6 | 9.8 |
| National Center for Medical Rehabilitation Research | 7.3 | 9.9 | 10.6 | 7.1 |
| **National Cancer Institute (NCI)** | | | | |
| Cancer Prevention & Control | 114.9 | 113.3 | 146.5 | 29.3 |
| **National Heart, Lung and Blood Institute (NHLBI)** | | | | |
| Heart & Vascular Diseases | 619.5 | 628.8 | 617.2 | -1.8 |
| Lung Diseases | 203.4 | 209.8 | 208.9 | -0.4 |
| **National Institute of Neurological Disorders and Stroke (NINDS)** | | | | |
| Biological Basis Research | 287.5 | 296.0 | 289.8 | -2.1 |
| Clinical Research | 191.7 | 199.6 | 197.7 | -1.0 |

**Table 19-4.** National Science Foundation (budget authority in millions)

| | FY 1992 actual | FY 1993 estimate | FY 1994 budget | % change FY 1993-94 |
|---|---|---|---|---|
| **Social, Behavioral & Economic Sciences (SBE)** | | | | |
| ***Social, Behavioral & Economic Research*** | | | | |
| Economic, Decision & Management Sciences | $21.5 | $20.9 | $23.7 | 13.8 |
| Social and Political Sciences | 14.6 | 15.1 | 17.3 | 14.5 |
| Anthropological & Geographic Sciences | 13.5 | 13.0 | 14.7 | 13.5 |
| Cognitive, Psychological & Language Sciences | 12.8 | 12.6 | 14.7 | 16.2 |
| Science, Technology and Society | 3.7 | 4.2 | 4.9 | 15.4 |
| Subtotal (Research) | 66.0 | 65.4 | 75.3 | 15.1 |
| ***International Cooperative Scientific Activities*** | 13.1 | 12.4 | 18.9 | 52.5 |
| ***Science Resources Studies*** | 6.9 | 11.7 | 12.7 | 8.6 |
| **Subtotal, SBE** | 86.0 | 89.5 | 106.9 | 19.4 |
| **Biological Sciences (BS)** | | | | |
| ***Integrative Biology and Neuroscience*** | | | | |
| Physiology & Behavior | 30.2 | 29.9 | 34.3 | 14.8 |
| Neuroscience | 31.1 | 30.8 | 35.5 | 15.1 |
| **Partial Subtotal, BS** | 61.3 | 60.7 | 69.8 | 15.0 |

# 20

# Federal Statistics in the FY 1994 Budget

*Edward J. Spar, COPAFS*

## OVERVIEW

Statistics produced by the federal government serve as a base for research in a broad spectrum of scientific disciplines. Population and vital statistics are central to the work of political scientists and demographers; employment, financial, and production data are essential for economists; and information on education and crime is used by sociologists and psychologists.

Researchers in the social sciences are not alone in their reliance on federal statistics. Epidemiologists and biostatisticians depend on data from the National Center for Health Statistics and the National Institutes of Health; meteorologists rely on information compiled by the National Oceanic and Atmospheric Administration; and scientists in an array of professions employ statistics that are gathered and distributed by agencies such as the National Science Foundation, the Energy Information Administration, the Environmental Protection Agency, the Soil Conservation Service, and the Geological Survey.

Responsibility for the collection, analysis, and dissemination of federal statistics is spread throughout the departments and independent agencies of the executive branch; each of some 70 agencies and departmental units annually spends $500,000 or more on statistical activities. Within this decentralized system that generates statistical information, a more limited number of agencies have the creation of statistics as their principal mission. It is these agencies that are responsible for producing statistics on major economic, demographic, and social developments and trends that are the focus of discussion in this chapter.

In general, the funding levels for FY 1994 that have been proposed for the principal statistical agencies do not provide significant increases over the resources appropriated in FY1993. For details of the funding history in fiscal years 1992 through 1994, see the table at the end of this chapter. One area where a major increase is requested is for the National Center for Education Statistics. This would cover added funds needed for the National Assessment of Educational Progress. Another large increase request comes from the National Center for Health Statistics. This increase would provide steps toward the establishment of a comprehensive system to monitor the impact of health reform. The balance of this chapter provides further details on FY 1994 programs.

## BUREAU OF THE CENSUS

The Bureau of the Census collects, compiles, and publishes a broad range of statistics on the population and the economy. Budget authority for the Census Bureau is provided in two appropriations: one covers current programs, including demographic surveys, international programs and data on construction, manufacturing, retail and wholesale trade, services, foreign trade, and state and local government finances and employment; the other covers periodic programs, including the decennial census of population, the quinquennial economic censuses, census of governments, and the census of agriculture. For FY1994, the proposed budget authority of $140.8 million for the current programs provides an increase of $13.4 million over FY 1993, an amount that would permit the Census Bureau to continue its base programs and to implement portions of the Economic Statistics Initiative. Proposed activities include the ability to expand and improve service sector and construction statistics, conduct research on the Standard Industrial Classification (SIC) system, and provide annual statistics on minority- and women-owned businesses. These activities are designed to augment the data currently collected every five years as part of the economic censuses. Periodic Censuses and Programs requests include funds to support the design and development of the automated systems required to conduct the test decennial census operation, including data collection systems. Also requested is support for the management of an automated continuously updated, geographic map base that includes the correct mailing address and geographic location of housing units, group quarters, farms, businesses, and industrial establishments. The computer file would provide address lists to serve as the coverage control and sampling frame for statistical activities.

## BUREAU OF LABOR STATISTICS

The Bureau of Labor Statistics (BLS), the principal fact-finding agency in the federal government in the field of labor economics, has a dual mission to: provide general purpose statistics that support the formulation of economic and social policy decisions in the business and labor communities, in legislation, and in other programs affecting labor; and serve the program needs of the Department of Labor and other federal agencies that use BLS data and research findings to administer and evaluate on-going programs, develop legislative proposals, and analyze economic and social problems. To meet these objectives, BLS collects, processes, analyzes, and disseminates data on employment and unemployment; prices and cost of living; consumer expenditures; wages and employee benefits; occupational injuries and illnesses; collective bargaining activities; productivity and technological change in U.S. industries; and projections of economic growth, the labor force, and employment by industry and occupation. For FY 1994, the proposed BLS budget is $330.7 million, a rise of $6.8 million over the estimated level for FY 1993. The request includes resources to support base programs; however, no new funding is requested for additional programs for FY 1994. Work, which began in 1990, would continue on the redesign of the Current Population Survey, and BLS would continue its efforts to improve and expand monthly estimates of employment, hours and earnings. Production and publication of data for the Prices and Cost of Living programs would continue. Labor force and industrial and occupational employment projections under alternative assumptions for the 1992-2005 period would be published for the Labor Force Projections program.

## BUREAU OF ECONOMIC ANALYSIS

The Bureau of Economic Analysis (BEA) prepares and interprets the economic accounts of the United States. These accounts consist of the national income and product accounts, summarized by the gross domestic product (GDP); the wealth accounts, which show the business and other components of national wealth; the input-output accounts, which trace interrelationships among industrial markets; regional economic accounts; and the United States balance of payments and associated foreign investment accounts. This work is supplemented by a system of business cycle indicators. For FY 1994, BEA's proposed budget authority would rise by $2.7 million over the FY 1993 level, to a total of $44.2 million. Funding has been requested to support the Economic Statistics Initiative, a multi-year initiative which places emphasis on activities to strengthen economic statistics. In the national economic accounts area, the requested increase provides funds to improve the quality of the GDP estimates and to modernize the U.S. national economic accounts and increase their international comparability. In the international accounts area, increases are requested to upgrade these accounts and better track increasingly complex and interrelated international markets for goods, services and capital. To address immediate quality issues in the national and international economic accounts, the proposed BEA budget includes funding for the development and acquisition of new and improved source data.

## STATISTICS OF INCOME, INTERNAL REVENUE SERVICE

The IRS Statistics of Income (SOI) program provides annual income, financial and tax-related data for individuals, corporations, partnerships, sole proprietorships and tax- exempt organizations, as well as special studies for the Office of the Secretary of the Treasury, including those in support of congressional mandates. For FY 1994, a total budget authority of $28.8 million is proposed for the SOI program, approximately equal to the FY 1993 level of $28.5 million. No major program changes are anticipated for FY 1994. Any new initiatives will continue to be funded through economies achieved through better quality management. Efforts will be concentrated on further improving data quality and timeliness, improved customer service and additional processing efficiencies.

## NATIONAL AGRICULTURAL STATISTICS SERVICE

The National Agricultural Statistics Service (NASS) has responsibility for collecting and publishing current statistics on the Nation's agriculture. NASS collects and reports data on a wide range of production, inventories, prices paid and received by farmers, costs of production, farm labor usage and wage rates, agricultural chemical use, and other agricultural statistics. For FY 1994, the proposed budget authority for NASS is $82.5 million, an increase of $1.5 million over FY 1993. Due to a FY 1993 budget decrease in funding for fruit commodity statistics, surveys of trees and vines will be conducted on an intermittent basis. Based upon the proposed FY 1994 budget, there would be no significant program changes.

## ECONOMIC RESEARCH SERVICE

The Economic Research Service (ERS) is responsible for research, situation and outlook analysis, staff analysis, and development of economic and statistical indicators in four major program areas: commodity economics, agriculture and trade analysis, resources and technology, and agriculture and the rural economy. For FY 1994, a funding level of $51.5 million is proposed for ERS, a decrease of $7.5 million from FY1993. The decrease would be achieved by reducing 1) analysis of farm credit and finance issues; 2) work in commodity research and market analysis; and 3) data purchases and support services. ERS would reduce its cooperative agreement program with the land-grant universities, not collect cost-of-production data for certain commodities, and eliminate the Western Livestock Marketing Information Program.

## ENERGY INFORMATION ADMINISTRATION

The Energy Information Administration (EIA) collects, analyzes, and disseminates information on energy resources, production, distribution, consumption, technology, and related international, economic, and financial matters. EIA produces reports with statistical time series, projections of future energy trends, and analyses of topical energy issues; EIA also supports the energy information requirements of the Department of Energy and other federal agencies. EIA's proposed FY1994 budget request is $89.4 million, an increase of $8.1 million over FY1993. The request supports existing requirements for energy information and analysis and allows EIA to begin work on new requirements of the Energy Policy Act of 1992 (EPACT). Specifically, the additional funds will support new programs in areas of energy end-use consumption; alternative transportation fuels; greenhouse gases; electricity production from renewable energy; uranium imports; and transportation rates for coal, oil, and natural gas. In addition, EIA will conduct the biennial Manufacturing Energy Consumption Survey and the Residential Transportation Energy Consumption Survey, and update the sampling frame for the Commercial Buildings Energy Consumption Survey to reflect 1990 Census information.

## NATIONAL CENTER FOR HEALTH STATISTICS

The National Center for Health Statistics (NCHS) monitors the Nation's health and use of health services and explores the relationship between risk factors and disease. Data sources include the Nation's vital statistics system and surveys involving personal interviews, physical examinations and laboratory testing, and information from health care providers. The mission of NCHS is to provide statistical information that will guide actions and policies to improve the health of the American people. Funding for NCHS comes from two major sources: direct budget authority and an allocation of Public Health Service "evaluation funds." Data from NCHS include the use of hospitals, nursing homes, physician services; financial and non-financial barriers to health care access; the health of racial and ethnic population groups; infant mortality; access to prenatal care; death from diseases such as cancer, heart disease, HIV/AIDS; and many others. For FY 1994, the budget authority request is $88.4 million, an increase of $8.0 million over FY 1993. This increase would provide for the first steps toward establishing a comprehensive system to systematically monitor the impact of health reform. The system would collect national data on the trends in health status, health insurance coverage, health care use, access to care and patient satisfaction at the beginning and throughout the period of implementation. FY 1994 steps would include an expanded National Health Interview Survey, reinstituting the National Nursing Home Survey, a major survey of the disabled population, continued full operation of the National Health and Nutrition Examination Survey, and the continued operation of the National Vital Statistics System.

## NATIONAL CENTER FOR EDUCATION STATISTICS

The National Center for Education Statistics (NCES) collects, analyzes and reports statistics on education in the United States, and conducts studies on comparisons of international education statistics. NCES also provides leadership in developing and promoting the use of standardized terminology and definitions for the collection of education statistics. For FY1994, a budget request of $125.0 million is proposed, an increase of $47.1 million over FY1993. Of the total, $65.0 million is requested to support the National Assessment of Educational Progress (NAEP). This would cover costs of data collection and validation studies in 1994; increased costs for training; transcript, analytic, equating and dissemination studies; and the costs for the National Assessment Governing Board. In 1994 NCES would conduct national assessments in three subjects at three grades, and state assessments in one subject at three grades. The balance of the FY1994 request would cover ongoing programs including more comprehensive data on institutions, faculty, students, finance, assessment methods, private school data, and more information on education and training outside of the usual institutional settings. The only new program proposed is an Early Childhood Longitudinal Survey in collaboration with other federal agencies whose programs focus on young children.

## BUREAU OF JUSTICE STATISTICS

The Bureau of Justice Statistics (BJS) is responsible for the collection, analysis, and publication of statistical information on crime, criminal offenders, victims of crime and the operations of justice systems at all levels of government and internationally. The mission of the Bureau is to provide accurate and timely justice data and to support the emerging capacity of state and local governments in the use of these data for their justice programs. The FY 1994 proposed budget authority is $21.4 million, which is the same as in FY1993 level. For FY 1994, continuation programs will include the National Crime Victimization Survey, the Drugs and Crime Data Center and Clearinghouse, the State Statistical Analysis Network, among others. There will also be a pre-test of a national Probation and Parole Survey which would be conducted over a two-year period. This survey would, for the first time, provide federal, state, and local policymakers a profile of drug-using offenders as well as the criminal careers of such offenders under supervision in the community by probation and parole agencies.

## BUREAU OF TRANSPORTATION STATISTICS

The Bureau of Transportation Statistics (BTS) compiles, analyzes, and produces information on the Nation's transportation system. BTS also collects information on modes of transportation and other areas as needed. It also enhances the quality and effectiveness of the statistical programs of the Department of Transportation (DOT) through research, the development of guidelines, and the promotion of improvements in data acquisition and use. The BTS was mandated by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and implemented in December 1992 as the newest operating administration within the DOT. For FY1993, BTS is funded at a $6.8 million level. The budget request for FY1994 is $15.0 million.

Programs that would be supported by the requested increase include the implementation of the Commodity Flow Survey with the Bureau of the Census, planning activities for a Passenger Flow Survey, and the development of data products for state and metropolitan planning organizations.

**Principal Federal Statistical Agencies (total direct funding in millions)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Budget |
|---|---|---|---|
| Bureau of the Census (Current Programs)[1] | $125.3 | $127.4 | $140.8 |
| Bureau of Labor Statistics | 300.6 | 323.9 | 330.7 |
| Bureau of Economic Analysis | 34.7 | 41.5 | 44.2 |
| Statistics of Income, IRS | 26.8 | 28.5 | 28.8 |
| National Agricultural Statistics Service | 82.6 | 81.0 | 82.5 |
| Economic Research Service, USDA | 58.9 | 58.9 | 51.5 |
| Energy Information Administration | 76.3 | 82.3 | 89.4 |
| National Center for Health Statistics[2] | 79.7 | 80.4 | 88.4 |
| National Center for Education Statistics[3] | 77.2 | 77.9 | 125.0 |
| Bureau of Justice Statistics[3] | 22.1 | 21.4 | 21.4 |
| Bureau of Transportation Statistics | — | 6.8 | 15.0 |

[1] The proposed FY 1994 budget for periodic programs at the Bureau of the Census is $130.9 million; these funds would be used to continue analysis and dissemination of 1990 decennial census data, accelerate planning for the year 2000 decennial census, and conduct the 1992 Economic Censuses.

[2] Funding levels shown for NCHS include $29.4 million in FY 1992, $28.9 million in 1993, and $28.9 million in FY 1994 from Public Health Service Evaluation Funds.

[3] Funding levels shown for NCES and BJS do not include S&E from other departmental sources; for FY 1994, NCES will have an estimated $9.9 million in S&E budget, and BJS will have an estimated $3.7 million in salaries, benefits, and administrative support.

## 21

# Mathematical Sciences in the FY 1994 Budget

*Lisa Thompson, JPBM*

## OVERVIEW

- FY 1993 spending by the federal mathematical sciences programs is estimated to be $169.9 million, about 0.8 percent more than FY 1992 spending of $168.6. In real terms, federal support for the mathematical sciences in FY 1993 is estimated to drop below the FY 1991 level.
- Federal support for the mathematical sciences in FY 1994 would total $187.3 million, or roughly 10.3 percent more than the estimated FY 1993 total. During the course of the budget process, however, reductions from this level are not unlikely.
- Growth in federal support for the mathematical sciences continues to be driven by the FCCSET research initiatives.
- The FY 1994 budget request for the NSF Division of Mathematical Sciences would be 13.6 percent higher than the estimated FY 1993 budget, which is estimated to drop below FY 1992 spending.
- DOD support for the mathematical sciences in FY 1994 would increase at a much greater rate than it has in the past two years.
- Proposed FY 1994 funding for the mathematical sciences at DOE would be constant at the FY 1993 level.

## TRENDS IN FEDERAL SUPPORT FOR THE MATHEMATICAL SCIENCES

For the last five years or so, federal support for the mathematical sciences has been growing at an annual rate of just 2 or 3 percent above inflation. For the most part, federal support for the mathematical sciences tracks overall support for basic research. Rapid growth in federal support for the mathematical sciences during the mid-1980s was concurrent with growth in overall federal support for basic research. Similarly, as spending increases for federal basic research programs slowed during the late 1980s and early 1990s, spending increases for federal mathematical sciences programs also slowed and spending would actually drop in real terms in FY 1993, if budget estimates hold.

Moreover, the federal basic research budget increasingly emphasizes the FCCSET research initiatives and other interdisciplinary activities, which account for much of the recent growth in mathematical sciences, program budgets. These strategic research programs, provide the field with important opportunities in the context of national science and technology goals. However, slower growth in overall funding for the mathematical sciences combined with enhanced funding for targeted research programs raises questions about the adequacy of support for research in core mathematics.

This is particularly true at the NSF, which is virtually the only source of support for fundamental mathematics research aimed at expanding the intellectual frontiers of mathematics. Increases for disciplinary research are built into budget requests, but Congress usually cuts the overall request and often shelters the strategic research initiatives. Although precise figures are not available, it appears that support for core mathematics has declined as a result.

It is also problematic that the balance between fundamental and strategic research in the mathematical sciences is not guided by an explicit well-founded principle but by the vagaries of the budget process.

DOD support for the mathematical sciences largely depends on the extent to which the field has the potential to contribute to the technology thrusts established at the highest levels of the department. Overall funding trends for DOD basic research are important but not indicative of DOD support for the mathematical sciences. In FY 1993, DOD support for the mathematical sciences is estimated to rise by only 1.2 percent above the FY 1992 level, while the percentage increase for Defense Research Sciences is estimated at 8.5 percent. In FY 1994, on the other hand, DOD support for the discipline would increase by 10.3

percent while Defense Research Sciences would decline by 1.3 percent. (See Table II-5.)

It should be noted that the increasingly quantitative nature of research in general hinders the complete accounting of federal support for mathematical scientists. For instance, NSF makes awards to Grand Challenges Applications Groups, multidisciplinary teams seeking to apply high performance computing techniques and resources to fundamental problems in science and engineering with broad economic and scientific impact. The involvement of the mathematical sciences in such an activity would not necessarily be reflected in the budget figures presented here.

## MATHEMATICAL SCIENCES PROGRAM BUDGETS FOR FY 1994

The table at the end of this chapter gives budget figures for the seven federal mathematical sciences programs, including estimates of spending in FY 1993 and budget proposals for FY 1994. All figures shown in the table and cited below are in terms of current dollars.

In FY 1994, combined spending by the seven mathematical sciences programs would grow by 10.3 percent above the estimated FY 1993 level. The budgets for five programs would grow in FY 1994, while budgets for two would remain flat. These budget proposals, however, are subject to the congressional budget process and to future revision by the responsible agencies. In particular, if recent trends hold, Congress is unlikely to appropriate funds for NSF research sufficient to allow the requested 12.2 percent increase in NSF support for the mathematical sciences.

Each funding agency provides support for a variety of research and related activities including individual and group awards, institutes, equipment, and education and human resources development. The figures given include funds spent or estimated to be spent by the federal mathematical sciences programs on various components of the mathematical sciences enterprise.

The DOD program figures include funding for several DOD-wide add-on programs including: Augmentation Awards for Science and Engineering Research Training (AASERT); the National Defense Science and Engineering Graduate Fellowship Program (NDSEG); Small Business Innovation Research (SBIR); and the University Research Initiative (URI). These add-on programs, often earmarked by Congress, cause fluctuations in budget figures as they are reported from one year to the next.

## National Science Foundation (NSF)

The NSF Division of Mathematical Sciences (DMS) fosters the creation and development of mathematical ideas and techniques, supports their interaction with theory and practice in other scientific and engineering disciplines, and encourages their diffusion into the infrastructure for education and human resource development and the technology base.

DMS provides about half of all federal support for the mathematical sciences, covering the broadest range of mathematical fields with support for individual investigators and small groups, research institutes, shared computing equipment, postdoctoral fellowships, research conferences, and undergraduate programs.

The FY 1993 current plan estimates DMS spending at $77.6 million, a drop of about 1 percent below FY1992 spending. This is the first drop in DMS spending from one year to the next since these annual analyses began. Under the FY 1994 NSF budget request, the DMS budget would be $88.0 million, a proposed increase of $10.4 million or 13.4 percent above the estimated FY 1993 level.

Starting with the FY 1994 budget documents, the DMS funding request is disaggregated into only two categories to comply with the Foundation's directive: research project support and special projects. The FY 1994 budget request proposes $69.9 million for research project support and $18.1 million for special projects.

In FY 1994, DMS plans to enhance the participation of the mathematical sciences in the five FCCSET research initiatives: Global Change Research, High Performance Computing and Communications, Advanced Materials and Processing, Biotechnology, and Advanced Manufacturing. DMS also would provide continuing infrastructure support for the discipline and significant expansion of activities designed to link research and education managed in collaboration with the Education and Human Resources Directorate.

## Air Force Office of Scientific Research (AFOSR)

The Mathematical and Information Sciences Directorate of AFOSR—which funds mathematical sciences activities in support of the Air Force mission—would spend $17.5 million for the mathematical sciences in FY1994. This budget would be slightly higher than the $17.0 million spent or budgeted in each of years FY1991, FY1992, and FY 1993.

## Army Research Office (ARO)

The ARO mathematical sciences program focuses on the mathematics of materials science, high performance computing, stochastic methods in image analysis, mathematical and computational issues in intelligent manufacturing, and other areas of interest. In FY 1993, the program estimates a slight budget drop, to $13.0 million, but in FY 1994 projects a 15.4 percent increase, which would bring the budget to $15.0 million. In FY 1994, the program would continue to fund the Mathematical Sciences Institute, the Center on Nonlinear Analysis and Mathematics of Materials Science, and the Army High Performance Computing Research Center. It would also support the Center on Foundations of Intelligent Systems with University Research Initiative (URI) funds, but would not establish any new centers in FY 1994.

## Advanced Research Projects Agency (ARPA)

The Applied and Computational Mathematics Program (ACMP) at ARPA emphasizes three major themes: advanced mathematical methods for signal and image processing and communications, with an emphasis on wavelets; high performance computational methods, with an emphasis on novel computational approaches and parallel computation; and modeling, simulation, and control, with emphasis on advanced materials processing.

The program maintains a base program and receives funding from the DOD add-on programs. The FY 1993 budget for ACMP is $12.2 million plus $6.5 million for the add-on programs. In FY 1994, spending would total $22.6 million, $12.4 million of which would be for ACMP, $6.2 million for the add-ons, and $4 million for initiating participation in the Advanced Materials Processing Program, supporting research on theory, mathematical modeling, and computational simulation of materials and materials processing.

Mathematics and computation play a significant role in several other ARPA programs and might play a supporting role in several areas under the Technology Reinvestment Project (TRP). However, since the TRP is intended to be composed of industry-led teams and has as a major goal turning technologies into products and/or processes, mathematics will play a role only to the extent that it supports this goal vis a vis such technologies as wireless communications and materials processing.

## National Security Agency (NSA)

The NSA Mathematical Sciences Program supports research in algebra, number theory, discrete mathematics, probability, statistics, and cryptology, and awards four kinds of grants: the Young Investigators Grant, the Standard Grant, the Senior Investigators Grant, and the Conferences and Special Situations Grant.

Due to overall spending cuts at the agency, support for the Mathematical Sciences Program has been dropping since FY 1990, when spending peaked at $3.4 million. The FY 1993 budget, originally estimated at $3.0 million, was cut twice and is now estimated to be $2.4 million. Under current plans, the program budget would remain at that level for FY 1994 although, as always, the budget is subject to reconsideration throughout the duration of the fiscal year.

## Office of Naval Research (ONR)

The Mathematical Sciences Division of the Office of Naval Research funds research in support of the naval mission, with designated programs in the areas of applied analysis, discrete mathematics, numerical analysis, operations research, probability and statistics, and signal analysis. It maintains a base program and also funds accelerated research initiatives (ARI's) as needed.

In FY 1993, the division estimates spending at about $10.0 million on the base program, about $5.5 million on ARI's, and $1.9 million on DOD add-on programs. The FY 1994 budget would include $10.2 million for base program support and $6.0 million for ARI's. The FY 1994 budget also includes an estimated $1.9 million from the add-on programs, including $1.3 million from AASERT, the amount the division received for this program in each of FY 1991, 1992, and 1993.

## Department of Energy (DOE)

Beginning in FY 1993, the scientific computing staff office, which administers the Applied Mathematical Sciences Program, was elevated to the Office of Scientific Computing, the head of which holds the title of Assistant Director of Energy Research for Scientific Computing. This office has two missions: to ensure the broad range of research in the mathematical and computer sciences necessary to underpin all the other sciences, and to manage an international network to provide state-of-the-art supercomputing facilities for DOE-supported researchers. Its work is proceeding in the context of the FCCSET High Performance Computing and Communications (HPCC) initiative, which encompasses R&D needed to produce the next generation of high performance computing hardware and software.

While the overall Applied Mathematical Sciences Program has grown somewhat over the past few years because of its association with the HPCC initiative, spending increases are directed to software development activities. The program's support for basic mathematical sciences—including research and related activities in analytical and numerical methods and information analysis techniques at universities and national laboratories—would remain unchanged in FY 1994 from its estimated level in FY 1993, $14.8 million.

## Other Federal Agencies

Several agencies—for instance, the National Aeronautics and Space Administration, the National Institutes of Health, and the National Institute of Standards and Technology—support mathematical sciences research, largely as an intramural activity. These and other agencies, such as the Environmental Protection Agency and the Department of Transportation, supply a limited number of grants to academic mathematical scientists. The table shows a rough estimate of $1.0 million for extramural support from federal agencies without dedicated mathematical sciences programs.

Federal Support for the Mathematical Sciences in Current Dollars (in millions)

| | FY 1991 Actual | FY 1992 Actual | FY 1993 Est. | FY 1994 Budget | Pct. Change FY 1993–94 |
|---|---|---|---|---|---|
| **National Science Foundation** | **81.2** | **86.4** | **85.6** | **96.0** | **12.2%** |
| DMS | 73.2 | 78.4 | 77.6 | 88.0 | 13.4% |
| Other NSF | 8.0 | 8.0 | 8.0 | 8.0 | 0.0% |
| **Department of Defense** | **66.1** | **67.7** | **68.5** | **75.5** | **10.3%** |
| AFOSR | 17.0 | 17.0 | 17.0 | 17.5 | 2.9% |
| ARO | 13.5 | 13.5 | 13.0 | 15.0 | 15.4% |
| ARPA | 16.7 | 17.8 | 18.7 | 22.6 | 20.9% |
| NSA | 3.1 | 3.1 | 2.4 | 2.4 | 0.0% |
| ONR | 15.8 | 16.3 | 17.4 | 18.0 | 3.6% |
| **Department of Energy** | **13.2** | **13.5** | **14.8** | **14.8** | **0.0%** |
| University Support | 6.7 | 5.4 | 5.4 | 5.4 | 0.0% |
| National Laboratories | 6.5 | 8.1 | 9.4 | 9.4 | 0.0% |
| **Other Agencies** | **1.0** | **1.0** | **1.0** | **1.0** | **0.0%** |
| **TOTAL, All Agencies** | **161.4** | **168.6** | **169.9** | **187.3** | **10.3%** |

DMS=Division of Mathematical Sciences; AFOSR=Air Force Office of Scientific Research; ARO=Army Research Office; ARPA=Advanced Research Projects Agency; NSA=National Security Agency; ONR=Office of Naval Research.

# 22

# Computer Science and Engineering Support in the FY 1994 Budget

*Juan Antonio Osuna, CRA*

## HIGHLIGHTS

- The High Performance Computing and Communications (HPCC) program is slated for a 37 percent increase, the largest increase in the history of the program.
- A large portion of the increase (30 percent) results from a new component called Information Infrastructure Technology and Applications, which President Clinton proposes to meet a wider spectrum of social needs.
- The Computing & Information Science & Engineering directorate of the National Science Foundation is slated for a 37 percent increase—a greater increase than that of any other directorate.
- The President proposes significant increases for the National Institute for Standards and Technology and the National Telecommunications and Information Administration, although much of these funds support HPCC without falling technically under the program.
- The National Science Foundation would receive a greater increase for HPCC (in dollars) than any other agency, and the Advanced Research Projects Agency would get the second largest increase (in dollars).

## OVERVIEW

As our society increasingly relies on information technology to conduct business and to sustain an informed democracy, the field of computer science and engineering is becoming more vital to the nation's economic and social health.

Recognizing this, the Clinton Administration proposes to increase the interagency High Performance Computing and Communications (HPCC) program by 37 percent over last year's level.

The HPCC's proposed $1.1 billion budget in FY 1994 would make it the most significant federal program for computer science and engineering researchers. Among the 10 federal agencies that participate in HPCC, the National Science Foundation (NSF) and the Advanced Research Projects Agency (ARPA) are the major players.

The NSF budget is slated for an overall 16 percent increase. Of all NSF directorates, Computer and Information Science and Engineering would get the largest increase—37 percent, bringing last year's budget of $215 million to $296 million in FY 1994.

The other major player, ARPA, recently dropped "Defense" from its name to reflect a new focus in developing technologies transferable to the private sector. Despite wide cuts in defense, the ARPA FY 1994 budget for HPCC is $343 million—a 25 percent or $68 million increase over FY 1993.

Also significant is a new program component to HPCC called Information Infrastructure Technology and Applications. President Clinton proposed this component as a way of meeting a wider spectrum of social needs.

## HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

Launched in 1991, the HPCC program grew out of years of negotiation between the executive and legislative branches. It is now authorized by legislation and by an initiative under the President's Federal Coordinating Council for Science, Engineering, and Technology. Today, these negotiations continue to guide the program in new directions.

Based on Clinton's budget, his policy statements, and discussions held in Congress, HPCC increasingly is seen as an economic catalyst and as an aid to solving a variety of social problems.

Originally, HPCC was conceived as a program to develop advanced computing tools needed by scientists working on specialized problems such as ocean modeling, drug design, advanced manufacturing, and digital anatomy.

Today, HPCC is seen as more than this; it is seen as a means to change the way businesses transact, teachers educate, and governments inform citizens.

The President's budget most significantly articulates this new focus by proposing a new component called Information Infrastructure Technology and Applications (IITA). Of HPCC's overall $324 million increase, $96 million (30 percent of the increase) would fund this new component.

Even without IITA, the HPCC budget for FY 1994 would reach $1 billion, which in itself is a substantial increase over the FY 1993 estimated funding of $772 million.

Including IITA, the HPCC program has five components:

- High Performance Computing Systems (HPCS): To develop massively parallel computing systems and associated software, reaching trillion operations per second (terop) and becoming accessible through wireless interfaces.

- Advanced Software Technology and Algorithms (ASTA): To develop software tools that meet Grand Challenges such as forecasting weather, predicting climate, building energy-efficient cars and airplanes, and designing better drugs. This component also funds the national supercomputer centers.

- National Research and Education Network (NREN): To extend the limits of high speed data communications through R&D, to widen educational access to high performance computers and digital libraries, and to develop prototype network technologies that the telecommunications industry could later adopt.

- Basic Research and Human Resources (BRHR): To support research, training and education in computer science and in computer engineering, and to initiate pilot projects for K-12 and life-long learning. This program element ensures a knowledge base the other components rely upon to succeed.

- Information Infrastructure Technology and Applications (IITA): To demonstrate prototype solutions to National Challenges, using high performance computers and networks. These Challenges include virtual reality, image recognition and digital libraries.

The IITA component provides funds to develop information systems for so-called "National Challenges," an extension of the "Grand Challenges" the HPCC program has traditionally funded.

National Challenges extend beyond specialized scientific research areas of the Grand Challenges to applications used by a wide cross-section of society. These applications involve areas of design and manufacturing, health care, education, digital libraries, environmental monitoring, energy demand management, public safety and national security.

In conjunction with industry's efforts, IITA will help spur the growth of a national information infrastructure, which one day will reach into everyone's home the way the telephone system does today. The Clinton Administration also calls for more use in government bureaucracies of computers and networks to record information and convey it to citizens.

These new policy directions will place greater demands on computer science and engineering researchers to develop systems that meet sweeping social needs in a way that ensures interoperability, user-friendliness, privacy, security and the protection of intellectual property rights.

The applicability of HPCC to society is as diverse as the federal agencies that support the program. Four agencies — NSF, ARPA, the National Aeronautics and Space Administration (NASA) and the Department of Energy(DoE), — have lead R&D roles, while six more — the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA), the National Institutes of Health (NIH), the Environmental Protection Agency (EPA), the National Security Agency (NSA) and the Department of Education (DoEd) — are primarily concerned as users of high performance computers and networks.

## DETAILS OF VARIOUS AGENCIES

### National Science Foundation (NSF)

The NSF primarily supports basic research but also funds projects to apply HPCC technologies to specific scientific problems. Within NSF, the Computer and Information Science and Engineering directorate is the major source of HPCC grant money. Its FY 1994 budget is $296 million, reflecting a 37 percent increase over FY 1993.

Of NSF's $2.2 billion budget for research and related activities, $341 million is allocated for HPCC, a 52 percent increase over FY 1993. NSF received a larger increase (in dollars) for HPCC than any other agency.

In coordinating the NREN portion of HPCC, NSF is upgrading NSFNET, the backbone of the Internet, by deploying network information services, offering more network connections, and expanding R&D to reach gigabit network speeds.

The NSF also funds four national supercomputer centers and plans to form a "metacenter" by connecting these centers with high-speed, gigabit networks that allow them to collaborate closely.

The NSF will also broaden its research to include digital libraries, multimedia computing and image recognition.

### Advanced Research Projects Agency (ARPA, Defense)

The HPCC budget for ARPA is $343 million—a 25 percent increase over the FY 1993 budget of $275 million. ARPA's increase (in dollars) is second largest, next to NSF. ARPA's overall budget will drop slightly from $2.250 billion to $2.182 billion.

ARPA has always been a major innovator of networking technologies; it developed the protocols now used on Internet. In FY 1994, ARPA will continue to develop networking technologies as well as a scalable technology base of interoperating workstations, parallel computing systems with mass storage, and systems software and development tools.

ARPA supports R&D projects throughout academia and industry.

### Department of Energy (DoE)

The DoE portion of HPCC is $124 million in FY 1994—a 23 percent increase over FY 1993. DoE funds HPCC research on parallel systems, software and high-speed networking technology. It investigates high performance computing applications in the areas of future energy resources, fusion energy, combustion, groundwater flow, petroleum reservoir modeling, atmospheric and oceanic modeling, and structural biology.

The DoE supports various high performance computing centers and the Energy Sciences Network (ESNET).

### National Institutes of Health (NIH, Health and Human Services)

The NIH budget for HPCC is $47 million for FY 1994, roughly equivalent to the FY 1993 budget.

The NIH is looking for ways to use high performance computers for comparing genetic and protein sequence data, biomedical imaging, developing digital libraries of biomedical images, and opening the NREN to medical researchers and centers.

### National Aeronautics and Space Administration (NASA)

The NASA budget for HPCC is $111 million for FY 1994—a 35 percent increase over FY 1993.

Funds would go to improving advanced aerospace vehicles; modeling interactions among the atmosphere, oceans and land masses; deploying NASA's portion of the NREN; and managing huge volumes of space data. The IITA efforts include increasing accessibility to remotely sensed data.

### National Security Agency (NSA, Defense)

This secretive intelligence agency is one of the largest consumers of computer hardware in the world. Its HPCC budget for FY 1994 is $42 million—an 8% decline from FY 1993.

NSA does research in interoperability, mass storage and high-speed networks, but specializes in computer and network security.

### Environmental Protection Agency (EPA)

The EPA HPCC budget is $12 million for FY 1994—a 50 percent increase over FY 1993. Research focuses on air and water pollution management and on ways to distribute environmental data to other public and state environmental groups.

### National Telecommunications and Information Administration (NTIA, Commerce)

Although the Department of Commerce receives little money for the HPCC program ($14 million), it will play an increasingly important role in supporting HPCC and transferring the fruits of HPCC to other areas.

Commerce oversees the National Telecommunications and Information Administration (NTIA) and the National Institute of Standards and Technology (NIST), both with key roles in information technology development.

The FY 1994 budget for NTIA more than doubles its current budget in order to launch the National Information Infrastructure (NII) Program, which would administer $51 million in grants.

"NTIA will provide matching grants to states, school districts, libraries, and other non-profit entities so that they can purchase the computers and networking connections needed for distance learning and for hooking into computer networks like the Internet," Clinton said in a policy statement.

With the new NII program, the NTIA FY 1994 budget is $95 million—a 137 percent increase over the FY 1993 budget of $40 million.

## National Institute of Standards and Technology (NIST, Commerce)

Also under Commerce, the NIST budget would jump 39 percent—from $383 million in FY 1993 to $535 million in FY 1994.

The Computer Systems program under NIST would more than triple from $12 million to $37 million. This money will be used for the development of technical standards for the National Research and Education Network.

Much of the funds for Commerce are not technically part of HPCC even though they clearly support HPCC.

**Table 1.** FY 1994 budget for the High Performance Computing and Communications program across federal agencies (budget authority in millions of dollars).

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request | Percent Change, FY 1993–94 | |
|---|---|---|---|---|---|
| | | | | Current $ | Constant $ |
| Advanced Research Projects Agency | $232 | $275 | $343 | 25% | 21% |
| National Science Foundation | 213 | 225 | 341 (IITA=$36*) | 52% | 47% |
| Department of Energy | 93 | 101 | 124 | 23% | 19% |
| National Aeronautics & Space Administration | 72 | 82 | 111 | 35% | 31% |
| National Security Agency | — | 46 | 42 | -9% | -13% |
| National Institutes of Health | 17 | 47 | 71 (IITA=$24) | 51% | 47% |
| National Oceanic & Atmospheric Administration | 3 | 10 | 24 (IITA=$12) | 140% | 133% |
| Environmental Protection Agency | 5 | 8 | 12 | 50% | 45% |
| Department of Education | — | 2 | 2 | 0% | -3% |
| National Institute of Standards & Technology | 3 | 2 | 26 (IITA=$24) | 1200% | 1161% |
| Total, Current Dollars | $638 | $798 | $1,096 | 37% | — |
| Total, Constant FY 1987 Dollars | $526 | $642 | $855 | — | 33% |

Source: Federal Coordinating Council for Science, Engineering, and Technology, Office of Science and Technology Policy, Executive Office of the President. Constant dollar conversions based on OMB's GDP deflators.

* This is the amount of HPCC funds earmarked for Information Infrastructure Technology and Applications (IITA), a new component proposed by President Clinton.

**Table 2.** FY 1994 budget for the HPCC program within the National Science Foundation broken down by component (budget authority in millions of dollars).

| Program Component | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request | Percent Change, FY 1993–94, NSF | |
|---|---|---|---|---|---|
| | | | | Current $ | Constant $ |
| High Performance Computing Systems | $24.0 | $25.8 | $34.3 | 32.9% | 29.0% |
| Advanced Software Technology and Algorithms | 103.0 | 107.6 | 140.0 | 30.1% | 26.2% |
| National Research and Education Network | 32.7 | 41.1 | 57.6 | 40.1% | 72.8% |
| Basic Research and Human Resources | 53.3 | 50.6 | 73.2 | 44.7% | 40.3% |
| Information Infrastructure Technology & Applications* | = | = | 36.0 | = | = |
| Total, Current Dollars | $213.0 | $225.1 | $341.1 | 51.5% | — |
| Total, Constant FY 1987 Dollars | $175.8 | $181.0 | $266.1 | — | 47.0% |

Source: National Science Foundation. Constant dollar conversions based on OMB's GDP deflators.

* Information Infrastructure Technology and Applications (IITA) is a new HPCC component proposed by President Clinton.

**Table 3.** FY 1994 budget for Computing & Information Science & Engineering Directorate of the National Science Foundation (budget authority in millions of dollars).

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request | Percent Change, FY 1993-94 | |
|---|---|---|---|---|---|
| | | | | Current $ | Constant $ |
| Computer & Computation Research | $34.77 | $34.80 | $46.07 | 32.4% | 28.4% |
| Information, Robotics & Intelligent Systems | 26.90 | 26.95 | 40.62 | 50.7% | 46.2% |
| Microelectronic Info. Processing Systems | 21.44 | 21.49 | 32.83 | 52.8% | 48.2% |
| Advanced Scientific Computing | 69.43 | 69.53 | 91.27 | 31.3% | 27.3% |
| Networking & Communications Research & Infrastructure | 35.38 | 39.96 | 54.94 | 37.5% | 33.4% |
| Cross-Disciplinary Activities | 22.44 | 22.49 | 30.28 | 34.6% | 30.6% |
| Total, Current Dollars | $210.37 | $215.22 | $296.01 | 37.5% | — |
| Total, Constant FY 1987 Dollars | $173.58 | $173.09 | $230.92 | — | 33.4% |

Source: National Science Foundation. Constant dollar conversions based on OMB's GDP deflators.

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# Electrotechnology–Related Research in the FY 1994 Budget

*Chris J. Brantley, IEEE-USA*

## HIGHLIGHTS

- $ 1 billion for multi-agency efforts on High Performance Computing and Communications, plus $96 million for Information Infrastructure Technology and Applications.
- $2.06 billion for Advanced Materials and Processing R&D, including R&D on superconducting materials for electric power transmission, intelligent materials and processes, optical/photonics, and packaging materials for advanced electronic devices.
- $ 1.4 billion for Advanced Manufacturing R&D, including intelligent control and sensor technologies and flexible computer-integrated manufacturing.

## INTRODUCTION

As these highlights suggest, investments in electrical, electronics and computing technologies (*i.e.*, "electrotechnologies") are an important component of the Clinton Administration's new Technology Initiative. This report provides an overview of R&D programs and funding levels at key agencies and highlights those electrotechnologies which are significantly affected by the Administration's budget proposal. It is not intended to be all-inclusive as time and space limitations preclude reporting on all electrotechnology-related programs funded by the $75.4 billion in federal R&D budget authority requested for FY 1994.

This analysis has been prepared primarily on the basis of budget figures provided by the federal departments and agencies on or after release of the President's budget on April 11, 1993. All figures are in current dollars, so requested increases (or decreases) do not reflect the impact of inflation. Percentage increases in FY 1994 funding are calculated based on FY 1993 appropriations. Unless specified, budget totals reflect the aggregate requests for conduct of R&D, R&D facilities, and program management costs.

## DEPARTMENT OF DEFENSE

The Department of Defense (DoD) budget request for Research, Development, Test, and Evaluation (RDT&E) is slated to increase a modest 1.2 percent to $38.6 billion in FY 1994. The DoD's RDT&E budget and defense-related research and facilities investment by other agencies comprise approximately 57 percent of the total federal R&D budget request—continuing the slow but consistent shift toward civilian research.

The Research and Development component of the RDT&E budget would decrease 6.6 percent to $25.6 billion. Funding for Technology Base (*i.e.*, basic and exploratory research) programs decreases 11 percent to $4.38 billion. Broken down by research categories, the budget proposes decreases for Research (down 5 percent to $1.12 billion), Exploratory Development (down 14 percent to $3.11 billion), and Advanced Development (down 13 percent to $9.39 billion). Engineering Development holds steady at $8.89 billion while funding for Management and Support jumps 7 percent to $2.98 billion.

Allocation of these funds varies through the Tri-services and Defense Agencies. Below is a brief overview with highlights of technology base and advanced technology development programs of particular relevance to electrical and electronics engineering:

*Army RDT&E* funding would decrease 13 percent to $5.25 billion in FY 1994. The R&D component drops 17 percent to $4.65 billion. Technology Base funding also decreases 18 percent to $832.2 million. Among programs of interest:

| | | |
|---|---|---|
| ■ Defense Research Sciences | + 0.9 % | $203.7M |
| ■ Electromechanics | + 0.7 % | $ 3.7M |
| ■ Electronic Survivability and Fuzing Technology | + 3.7 % | $ 28.8M |
| ■ Electronics/Elect. Devices | - 6.7 % | $ 19.4M |

| | | |
|---|---|---|
| ■ Command, Control & Communications ($C^3$) | - 39.3 % | $ 10.4M |
| ■ Computer & Software Tech. | + 95.5 % | $ 5.7M |
| ■ Artificial Intelligence | - 13.6 % | $ 2.7M |

Advanced Technology Development would drop 48.5 percent from its FY1994 peak to $434.7 million, slightly above FY1992 funding levels. Among programs of interest:

| | | |
|---|---|---|
| ■ $C^3$ Advanced Technology | + 63.8 % | $ 16.0M |
| ■ Global Surveillance/Air Defense Tech. Demons. | - 14.6 % | $ 29.5M |
| ■ Electronic Warfare Tech. | - 30.0 % | $ 28.5M |
| ■ Advanced Electronic Devices Development | -100.0 % | $ 0.0M |
| ■ Advanced Tactical Computer Science and Technology | + 66.4 % | $ 30.9M |

*Navy RDT&E* would increase by 3 percent to $9.22 billion in FY 1994. R&D drops 5.6 percent to $6.11 billion. Technology Base funding falls 11 percent to $964 million with adjustments for:

| | | |
|---|---|---|
| ■ Defense Research Sciences | + 1.9 % | $416.9M |
| ■ $C^3$ Technology | - 9.6 % | $ 18.2M |
| ■ Materials, Electronics & Computer Technology | - 24.9 % | $ 71.1M |
| ■ Electronic Warfare Tech. | - 9.6 % | $ 14.9M |
| ■ Undersea Surveillance Tech. | - 19.8 % | $107.9M |
| ■ Ocean & Atmospheric Tech. | - 15.9 % | $ 37.7M |

Advanced Technology Development increases 96 percent to $418.5 million, with several programs showing significant changes:

| | | |
|---|---|---|
| ■ Air Systems Adv. Tech. Dev. | + 4.3 % | $ 30.1M |
| ■ Global Surveillance/Air Defense Tech. Demons. | + 445.4 % | $ 50.9M |
| ■ Advanced EW Technology | - 53.5 % | $ 12.9M |
| ■ Advanced Tech. Transition | - 26.8 % | $ 63.4M |
| ■ $C^3$ Advanced Technology | - 55.6 % | $10.7M |

*Air Force RDT&E* would increase by 4.1 percent in FY1994 to $13.69 billion. The R&D component drops 4 percent to $6.92 billion. Technology Base funding would grow 1 percent to $1.01 billion with increases for:

| | | |
|---|---|---|
| Defense Research Sciences | + 2.4 % | $241.3M |
| Aerospace Avionics | + 5.5 % | $ 74.8M |
| Rocket Propulsion and Astronautics Tech. | + 11.2 % | $ 40.0M |
| C$^3$ | + 16.4 % | $ 95.9M |

Advanced Technology Development would decrease by 15.8 percent to $589.3 million. Among programs of interest:

| | | |
|---|---|---|
| Adv. Avionics/Aero. Vehicles | + 22.6 % | $ 49.2M |
| Global Surveillance/Air Defense Tech. Demons. | +220.8 % | $ 14.9M |
| Adv. Avionics Integration. | + 31.7 % | $ 30.4M |
| Nat'l Aero-Space Plane | - 69.4 % | $ 43.3M |
| EW Technology | - 16.2 % | $ 25.7M |
| C$^3$I Subsystem Integration | + 79.7 % | $ 15.9M |
| Advanced Computing Tech. | + 22.4 % | $ 19.6M |
| C$^3$ Advanced Development | + 86.0 % | $ 17.1M |

*RDT&E in the Defense Agencies* would increase by 3.8 percent to $10.17 billion. R&D would fall 2.5 percent to $7.66 billion with decreases for Research (down 18.9 percent to $357 million) and Advanced Development (down 5 percent to $5.6 billion) and an increase for Engineering Development (up 27.8 percent to $129.7 million).

The reoriented Strategic Defense Initiative Organization (SDIO) would receive $3.64 billion in FY1994, a decrease of 2.3 percent. SDIO program lines include:

| | | |
|---|---|---|
| Limited Defense System | - 30.3 % | $2134.8M |
| Theater Missile Defenses | + 64.2 % | $1686.7M |
| Other Follow-up Systems | + 14.8 % | $ 354.2M |
| Research and Support Act. | - 1.3 % | $ 358.2M |
| SBIR/Tech.Transfer Pilot Prog. | + 2.5 % | $ 42.6M |

The Advanced Research Projects Agency (ARPA) funding would decrease by 3 percent to $2.18 billion. ARPA Technology Base programs decline by 13.5 percent to $847.9 million. Among programs affected:

| | | |
|---|---|---|
| ■ Defense Research Sciences | - 27.3 % | $ 79.7M |
| ■ Computing & Commun. Tech. | + 5.5 % | $368.6M |
| ■ Tactical Technology | + 46.8 % | $143.9M |
| ■ Integ. Command/Control Tech. | - 62.4 % | $ 57.2M |
| ■ Materials & Electronics Tech. | - 22.2 % | $198.5M |

Advanced Technology Development within ARPA would increase by 2.8 percent to $1.278 billion. Programs affected include:

| | | |
|---|---|---|
| ■ Experimental Evaluation of Major Innovative Tech. | + 78.7 % | $512.2M |
| ■ Dual-Use Partnerships | - 42.3 % | $324.0M |
| ■ Manufacturing Tech. | + 36.6 % | $299.6M |
| ■ Semiconductor Manuf. Tech. | + 5.4 % | $100.0M |

## DEPARTMENT OF ENERGY

Total FY 1994 budget authority for the Department of Energy (DOE) would increase 3 percent to $19.56 billion. DOE's defense-related weapons, environmental restoration, and nuclear waste disposal programs still represent over 63 percent of the Department's total budget— totalling $12.38 billion in the FY 1994 budget request. Of the DOE budget request, $7.53 billion (an increase of 1.9 percent) is allocated to conduct of civilian and defense R&D and R&D facilities.

DOE's request for Energy Supply R&D grows 27 percent to $3.15 billion. Solar and Renewable Energy R&D programs would grow 3.6 percent to $327.2 million with increases for photovoltaics (up 22.5 percent to $78 million), solar thermal (up 24.5 percent to $32.7 million), solar building energy systems (up 71.6 percent to $5.0 million), biofuels (up 23.4 percent to $58.2 million), wind energy (up 29.9 percent to $30.4 million), and solar technology transfer (up 743 percent to $16.4 million). Geothermal increases 5.3 percent to $23.9 million, hydropower drops 1.5 percent to $.9 million, and funding for ocean energy systems is eliminated.

A total of $49.9 million is requested for Electric Energy and Storage Systems (an increase of 17 percent) with major funding for research on system reliability and control ($6.1 million), health effects of electric and magnetic fields ($10 million), and High Temperature Superconductivity ($20.7 million).

Reflecting the Clinton Administration's de-emphasis of nuclear power, funding for Nuclear R&D activities drops 6.7 percent to $309.6 million. Support for development and certification of advanced light water reactors drops 2 percent to $57.8 million. Funding for Advanced Reactor R&D on Advanced Liquid Metal Reactor and Modular High Temperature Gas Reactor concepts is eliminated except for $15 million for continuing research on recycling of actinides within a closed metal fuel cycle. The request for Advanced Radioisotope Power Systems used by DOD and NASA is $48.1 million. Funding for Space Reactor Power Systems is cut by 83 percent to $5 million for concept studies.

DOE's support for Fusion R&D grows 2.3 percent to $347.6 million. The Magnetic Fusion program would support U.S. participation in the International Thermonuclear Experimental Reactor (ITER), deuterium-tritium fuel experiments in the Tokamak Fusion Test Reactor, planning for a future experimental facility to develop advanced tokamak modes, and basic physics and technology research. The Inertial Confinement Fusion program is funded for research on heavy ion accelerators.

Also within the $1.76 billion allocated for Energy Research funding, Basic Energy Sciences falls 6.8 percent to $801.9 million, $39 million is requested for development of an Advanced Neutron Source, the University and Science Education Program grows 4 percent to $58 million, energy research at the Multi-Program Energy Laboratories is funded at $41.6 million, and the ER Laboratory Technology Transfer Initiative drops to $39.4 million.

DOE's request for Fossil Energy R&D drops 5 percent to $398.4 million. The only programs anticipating increases are Coal Combustion Systems (up 19 percent to $43.8 million), Enhanced Oil Recovery (up 59 percent to $73.2 million) and Natural Gas Research (up 76 percent to $51.7 million).

A new DOE priority, Energy Conservation/Efficiency programs, jump 35 percent to $762.6 million. Increases are slated for the Transportation (up 32 percent to $184.7 million), Industrial (up 54 percent to $137.1 million), Buildings (up 87 percent to $98.4 million), and Utility (up 37 percent to $6.8 million) sectors. In the Transportation program, DOE would provide $82.6 million (an increase of 38 percent) for cost-sharing of the U.S. Advanced Battery Consortium and related fuel cell and hybrid propulsion research.

DOE's General Science and Research budget would increase 12.2 percent to $1.6 billion, including $613.4 million for High Energy Physics, $635 million for the Superconducting Super Collider, and $322.3 million for Nuclear Physics.

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Administration proposes a FY 1994 budget of $15.3 billion for the National Aeronautics and Space Administration (NASA), an increase of 6.5 percent. NASA funding for research and development would grow 8.8 percent to $7.71 billion.

Despite an on-going redesign effort, the Space Station Freedom program is tentatively slated for an 8.4 percent increase to $2.3 billion, which includes a related emphasis on new technology investments.

The $649.2 million requested for Space Transportation Capability Development shifts priorities within a flat budget with increases planned for Space Lab, Advanced Programs, and Research Operations Support, and corresponding decreases to the Engineering & Technical Base, Payload Operations, Tethered Satellite System, and Advanced Propulsion Technology.

The Space Science and Applications budget has been reorganized around three new program offices. Funding for Space Science, including physics, astronomy, and planetary exploration, would increase 3.4 percent to $1.63 billion with support for the Advanced X-Ray Astrophysics Facilities ($260.3 million) and the Cassini probe ($266.6 million). Life and Microgravity Sciences and Applications programs would increase 150 percent to $351 million, reflecting incorporation of the $117 million requested for Shuttle/Spacelab payload mission management and integration. Finally, Mission to Planet Earth would drop 6 percent to $1.07 billion due to program transfers but provides $322.7 million for the Earth Observing System and $182.7 million for its related Data Information System. Mission to Planet Earth also encompasses the Advanced Communications Technology Satellite (ACTS) which is scheduled for a 1993 launch.

Space Research and Technology would increase by 9.4 percent to $298.2 million, and includes 160.8 million for technology base research and $137.4 million for the Civil Space Technology Initiative, with emphasis on development of new space science, transportation, space platforms, and operations technologies.

Commercial Space Programs grow 4.6 percent to $172.0 million with an increase of 7.6 percent for NASA's Centers for the Commercial Use of Space (to $145.1 million) and transfer of $1.1 million for a Search and Rescue program from the Space Science and Applications budget.

Reflecting the Clinton Administration's emphasis on renewing the competitiveness of U.S. aviation, funding for Aeronautics Research and Technology would increase by 18.6 percent to $1.02

billion, including $448.3 million for research and technology base programs, $65.6 million for high performance computing, $187.2 million for high-speed research, and $101.3 million for Advanced Subsonic Technology.

Among other NASA programs, new funding of $80 million is requested for Transatmospheric Research and Technology; funding for Academic Programs decreases 20 percent to $74.5 million; and NASA proposes termination of the National Launch System, the Space Exploration Initiative, and the space nuclear power program. The operations request for Space Flight, Control and Data Communications increases 4.5 percent to $5.32 billion to support shuttle upgrades and operations, launch services, and space and ground networks and communications systems

## NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

The Administration has requested a FY 1994 budget appropriation of $535.2 million for the National Institute of Standards and Technology (NIST), a 39 percent increase which reflects the Clinton Administration's shift toward applied research and precompetitive technology development. NIST also projects $221 million in revenue from contract research and fees paid by other agencies for a total resources budget of $756 million.

NIST's scientific and technical research programs would grow 24.9 percent to $240.99 million, of which $192.8 million is characterized as conduct of R&D. Electronics and electrical measurements would increase 13.6 percent to $30.67 million, including new funding for semiconductor metrology and microwave measurements. Other laboratory requests with significant electrotechnology components include $14.4 million for manufacturing engineering (precision electronic components), $37.08 for computer systems (high performance computing and communications), and $47.2 million for advanced materials ("intelligent" materials manufacturing methods), and $7.0 million for applied mathematics and scientific computing.

Funding for NIST's Industrial Technology Services would nearly triple to $232.5 million. The Advanced Technology Program request increases 194 percent to $199.5 million to fund 100 new awards for pre-competitive technology research. The budget provides $30.2 million for a reorganized Manufacturing Extension Partnership which incorporates the seven regional Manufacturing Technology Centers, the State Technology Extension Program, and a new initiative to network existing extension centers and technology sources throughout the country. A new Quality Program funded at $2.8 million would integrate the current Malcolm Baldrige National Quality Award with an expanded quality outreach effort.

## NATIONAL SCIENCE FOUNDATION

Under President Clinton's FY 1994 budget request, funding for the National Science Foundation's (NSF) research and related programs would increase by 18.4 percent to $2.20 billion. Nearly half of this funding is focused on five critical research and technology priorities: Advanced Materials and Processing ($328.0 million), Biotechnology ($215.6 million), High Performance Computing and Communications (304.96 million), and U.S. Global Change Research ($170.05 million), and Advanced Manufacturing Technologies ($130.25 million).

NSF's Computer and Information Science and Engineering (CISE) Directorate jumps 37.5 percent to $296 million. Of this total, $253.87 million is directed toward High Performance Computing and Communications including $54.9 million, a 14.2 percent increase, for research on the proposed National Research and Education Network.

The Engineering Directorate grows 23.7 percent to $323.1 million with monies directed toward initiatives in Advanced Materials and Processing ($76.2 million), High Performance Computing and Communications ($6.31 million), Advanced Manufacturing Technologies ($80.40 million), and Small Business Innovative Research ($33.12 million). Total funding for Electrical and Communications Systems research is up 25 percent to $42.8 million. Funding for the Engineering Research Centers grows 10.5 percent to $52.5 million to support two new centers for research on advanced intelligent manufacturing and materials synthesis and processing.

# 24

# Mechanical Engineering in the FY 1994 Budget

*ASME Inter-Council Committee on Federal R&D*
*(James R. Welty, Chairman)*

Mechanical engineering research and development (R&D) budget figures are included in several federal programs. It is worth mentioning that the Clinton Administration's FY 1994 budget request includes significant increases at the National Science Foundation (NSF) with a proposed $24.58 million increase and at the National Institute of Standards and Technology (NIST) with a proposed $151.20 million increase.

Individual agency funding trends are presented in Table I. The table and the following analysis represent programs which involve strong mechanical engineering R&D components.

**TABLE I.** Mechanical Engineering R&D (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| Department of Energy | 1,157.81 | 1,237.52 | 1,312.23 |
| National Science Foundation | 120.05 | 120.99 | 145.57 |
| National Aeronautics & Space Administration | 6,827.60 | 7,089.30 | 7,712.30 |
| National Institute of Standards & Technology | 246.72 | 384.00 | 535.20 |
| Environmental Protection Agency | 108.99 | 106.99 | 112.95 |
| Department of Defense | 38,116.00 | 38,176.00 | 38,620.00 |
| Department of Transportation | 255.94 | 570.19 | 547.52 |
| Total | 46,833.11 | 47,684.99 | 48,985.77 |

## THE DEPARTMENT OF ENERGY

The FY 1994 DOE budget request for basic research, which is the mandate for the Division of Basic Energy Sciences, is $801.96 million of which $628.99 million is for direct support of research at national laboratories, universities, other government laboratories, and industry. The combined increases in these programs would be 4.9 percent and support the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) crosscut initiatives in biotechnology and advanced materials processing. The Engineering Research program figure for FY 1994 also includes an initiative in research related to advanced manufacturing.

The FY 1994 request for Energy Conservation R&D is approximately 24 percent higher than the FY 1993 appropriations and reflects the directions outlined in the Energy Policy Act of 1992 (EPACT '92). The budget request shows an increase in all the categories, specifically: a 10 percent increase in the transportation sector; a 21.5 percent increase in the industrial sector; and a 65 percent increase in the buildings sector. Table II shows the energy conservation R&D budget listed by end use categories.

The request for the solar and renewable energy budget also shows a healthy increase of 27 percent, reflecting the directions outlined in the EPACT '92. The Solar energy budget shows an overall 32.5 percent increase, including: 65 percent in solar building technology research; 22 percent in photovoltaics; 25 percent in solar thermal energy research; 23 percent in biofuels research; and 30 percent in wind energy research. In addition, the FY 1994 budget request shows that the thermal energy storage programs would be shut down.

The total budget request for Fossil Energy R&D amounts to $406.4 million. Included in this estimate are several programs of interest to mechanical engineering, including $141.3 million for Coal R&D and $181.8 million for Petroleum and Natural Gas Technologies. These figures represent a 25 percent reduction in Coal R&D from the FY 1993 levels and an increase of 27 percent for Petroleum and Natural Gas Technologies.

The FY 1994 funding for Nuclear Energy R&D would be 47 percent below the FY 1993 appropriations. This includes decreases of $45 million in Advanced Reactor R&D, $25 million in space reactor power systems, and $0.9 million in light water reactors. The FY 1994 funding for Civilian Radioactive Waste R&D would be 85 percent below the FY 1993 appropriation. This includes a $3.9 million decrease in spent fuel storage development.

The figures given in Table II for Nuclear Energy and Civilian Radioactive Waste R&D reflect the level of effort in civilian nuclear R&D activities involving mechanical engineering R&D.

**TABLE II.** The Department of Energy R&D (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| **Basic Energy Sciences** | | | |
| Engineering Research | 16.18 | 16.54 | 17.33 |
| Materials Science | 132.24 | 136.40 | 143.09 |
| **Energy Conservation R&D** | | | |
| Transportation Sector | 109.30 | 167.90 | 184.70 |
| Industrial Sector | 96.70 | 112.80 | 137.10 |
| Building Sector | 47.10 | 59.70 | 98.40 |
| Utility Sector | 4.70 | 5.00 | 6.80 |
| **Solar & Renewable Energy** | | | |
| Solar Energy | 174.25 | 187.43 | 248.36 |
| Geothermal Energy | 26.88 | 23.40 | 23.97 |
| Hydropower | 1.03 | 1.05 | 1.08 |
| Electric Energy Systems | 30.42 | 32.30 | 38.58 |
| Energy Storage Systems | 7.21 | 10.30 | 11.32 |
| **Fossil Energy** | | | |
| Coal R&D | 225.6 | 188.6 | 141.3 |
| Petroleum & Natural Gas | 119.7 | 142.9 | 181.8 |
| **Nuclear Energy & Civilian Radioactive Waste R&D** | 166.50 | 153.20 | 78.40 |
| **Total** | 1,157.81 | 1,237.52 | 1,312.23 |

## THE NATIONAL SCIENCE FOUNDATION

Support for mechanical engineering research within the Engineering Directorate at NSF would increase by 20.3 percent, exceeding the overall NSF increase of 15.2 percent. Details of the program-by-program budgets are shown in Table III.

The total Directorate budget would increase by 23.8 percent and Engineering would again exceed 10 percent of the NSF budget (FY1992 was the initial time) but would only return to the share it had two years ago. Of the $24.58 million increase, a larger share goes to programs that fund individual projects and small research groups as they participate in NSF-wide efforts in critical technology areas of national importance.

Priority areas include the FCCSET-defined areas of High Performance Computing and Manufacturing as well as NSF-defined areas of Health Care, Civil Infrastructure, and Environmental Restoration.

Funding for Academic and Research Instrumentation and Facilities, requested at a level of $55 million, would be equally committed to Academic Research Instrumentation and Research Facilities Modernization. Some portions of this may also aid mechanical engineering research programs.

The proposed increase of 12.1 percent in Industry Innovation and Interface includes an increased emphasis on the transfer of science and technology; the management of technological innovation; and industry, university, and government partnerships. It is expected that portions of this funding will be relevant to mechanical engineering research.

**TABLE III.** The National Science Foundation (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| **Chemical & Thermal Systems Division** | | | |
| Interfacial. Transport & Separations Processes | 9.11 | 8.72 | 10.25 |
| Fluid, Particulate & Hydraulic Systems | 9.79 | 8.84 | 10.78 |
| Thermal Systems | 8.2 | 7.75 | 9.85 |
| **Design & Manufacturing Systems Division** | | | |
| Operations Research & Production Systems | 5.86 | 6.87 | 8.35 |
| Design & Integration Engineering | 5.81 | 6.82 | 8.29 |
| Manufacturing Process & Equipment | 10.85 | 12.87 | 16.16 |
| **Engineering Education & Centers Division** | | | |
| Engineering Research Centers | 47.50 | 47.50 | 52.50 |
| Industry/University Cooperative Research Centers | 6.70 | 6.70 | 9.20 |
| **Industry Innovation Interface Division** | | | |
| Industry/University Cooperative Projects | 0 | 0 | 1.00 |
| **Mechanical & Structural Systems** | | | |
| Dynamic Systems & Control | 4.29 | 3.62 | 4.87 |
| Surface Engineering & Tribology | 2.52 | 2.55 | 3.37 |
| Mechanics & Materials | 9.42 | 8.75 | 10.95 |
| **Total** | 120.05 | 120.99 | 145.57 |

## THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA R&D programs which involve mechanical engineering would grow by approximately 8 percent over the FY 1993 levels Table IV shows the distribution of NASA's R&D funds for FY 1994.

At the time of this review, specific funding details were not available concerning Space Station Freedom which is undergoing redesign. Depending on the selected option and program restructuring, the President's New Technology Initiative would receive funding shifted from the Station to support near-term innovative research in areas such as aeronautics, automation, and robotics and other technology projects which involve mechanical engineering, as well as aerospace in general.

The Space Science and Application programs would be reorganized to focus on three areas: Space Science (Physics and Astronomy, as well as Planetary Exploration), Life and Microgravity Science, and Mission to

Planet Earth (MPE). In Space Science, the Advanced X-Ray Astrophysics Facility (AXAF) and Cassini missions would be continued. In Microgravity Science, efforts would continue in materials processing, fluid physics, and hardware development to support flight experiment research facilities. MPE would continue to fund the Earth Observing System and Earth Probes.

Aeronautics would see a significant jump of almost 18 percent as emphasis is placed on critical technologies including high performance computing (115 percent increase), high speed civil transport (60 percent increase), and advanced subsonic technology (716 percent increase). In addition, the Transatmospheric Research and Technology program is included to continue NASA's contribution to the National Aerospace Plane (NASP) program in areas of propulsion, materials, and structures, control, and application of computational fluid dynamics. High risk program elements (primarily aeropropulsion) and hypersonic flight tests of critical technology elements are the near term focus.

**TABLE IV.** National Aeronautics and Space Administration (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| **Space Station & New Techs. Investment** | 2,002.8 | 2,122.5 | 2,300.0 |
| **Space Transportation Capability Development** | 739.7 | 649.2 | 649.2 |
| **Space Sciences** | | | |
| Physics & Astronomy | 1,036.7 | 1,103.8 | 1,074.7 |
| Planetary Exploration | 534.2 | 473.7 | 557.2 |
| Life Sciences | 157.6 | 140.6 | — |
| Materials Processing | 120.8 | 172.9 | — |
| Earth Sciences | 725.4 | 863.8 | — |
| Communications | 20.0 | 5.0 | — |
| Information Systems | 35.0 | 36.2 | — |
| Research Operation Support | 83.9 | 70.0 | — |
| **Life & Microgravity Sciences** | — | — | 351.0 |
| **Mission to Planet Earth** | — | — | 1,074.9 |
| **Advanced Concepts & Technology** | | | |
| Space Research & Technology | 309.2 | 272.7 | 298.2 |
| Commercial Programs | 147.6 | 164.4 | 172.0 |
| **Aeronautics** | | | |
| Aeronautical Research & Development | 788.2 | 865.6 | 1,020.7 |
| Transatmospheric Research & Development | 4.1 | — | 80.0 |
| **Safety, Reliability & Quality Assurance** | 33.6 | 32.7 | 35.3 |
| **Academic Programs** | 66.8 | 92.9 | 74.5 |
| **Tracking & Data Advanced Systems** | 22.0 | 23.3 | 24.6 |
| Total | 6,827.6 | 7,089.3 | 7,712.3 |

## THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

The FY1994 budget request for NIST is $535.2 million, up 39 percent from the FY1993 appropriation of $384.0 million. The Scientific and Technical Research and Services (S&TR&S) component of $241.0 million is a 25 percent increase and the Industry Technical Services component is a significant 170 percent increase.

The S&TR&S appropriation covers ten areas. For the second year, the largest increase is for computer systems. The FY1994 request of $37 million is a 205 percent increase over the FY1993 appropriation of $12 million. Activities in this element include efforts to develop computer and telecommunications system standards and support for the High Performance Computing and Communication/Information Infrastructure Initiative. Materials Science and Engineering is the largest element of S&TR&S at an FY 1994 request of $47 million, an increase of 33 percent. Support for the Advanced Materials and Processing Initiative is expanded to focus on development of technical tools to turn advanced materials into manufacturing engineering, up 43 percent from 10.1 million. Through this program, NIST develops methods, standards, and technologies for mechanical manufacturing industries to improve their production lines.

The Industrial Technology Services component has two major elements: the Advanced Technology Program (ATP) and the Manufac-

**TABLE V.** The National Institute of Standards and Technology (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| **Scientific & Technical Research & Services** | | | |
| Electronics & Electrical Measurements | 25.04 | 26.51 | 30.67 |
| Manufacturing Engineering | 9.49 | 10.09 | 14.40 |
| Chemical Science & Technology | 18.53 | 19.30 | 23.05 |
| Physics | 25.47 | 26.37 | 26.88 |
| Materials Science & Engineering | 27.68 | 35.57 | 47.24 |
| Building & Fire Research | 10.98 | 12.07 | 12.87 |
| Computer Systems | 11.80 | 12.14 | 37.08 |
| Applied Mathematics & Scientific Computing | 6.49 | 6.78 | 7.00 |
| Technology Assistance | 7.85 | 8.52 | 10.53 |
| Research Support Activities | 36.55 | 35.59 | 31.26 |
| **Industrial Technology Services** | | | |
| Advanced Technology Program | 49.86 | 67.88 | 199.49 |
| Manufacturing Extension Partnership | 16.98 | 18.18 | 30.24 |
| Quality Program | — | — | 2.80 |
| **Construction of Research Facilities** | | | |
| Construction & Major Renovations | — | 105.00 | 61.69 |
| Total | 246.72 | 384.00 | 535.20 |

turing Extension Partnership (MEP). The ATP leverages industry resources for their development of high risk technologies. The FY 1994 request of $199 million is a 194 percent increase over the FY 1993 appropriation of $67 million. The request for the MEP is $30 million, an increase of 66 percent. The MEP is designed to create technical resource centers across the country to provide assistance to small and medium sized manufacturing companies.

## THE ENVIRONMENTAL PROTECTION AGENCY

Funding for engineering research by media is listed in Table VI. The overall R&D expenditures at EPA for FY1994 would increase by approximately six percent from the FY 1993 level of $107 million.

The Air Research program will be funded at roughly the same level as in FY1993 to provide support for the implementation of the Clean Air Act Amendments and to investigate pollution prevention techniques to reduce emissions of indoor air pollutants. The Radiation Research program will be phased out in 1994 with these resources being redirected into the air research program to conduct related indoor air engineering research.

The FY1994 Water Quality (36 percent decrease), Hazardous Waste (41 percent decrease), Superfund (20 percent decrease), and Toxic Substances Research (52 percent) programs all show substantial reductions due to a redirection of resources to fund higher priority research.

The significant 260 percent increase to the Multimedia Engineering program is primarily to support the President's Environmental Technology Initiative (ETI). Other increases are for advanced manufacturing techniques and pollution prevention. Oil Spill Research includes a moderate funding increase to improve response actions to serious oil spills.

**TABLE VI.** The Environmental Protection Agency (Millions of Dollars)

| | FY 1992<br>Actual | FY 1993<br>Estimate | FY 1994<br>Request |
|---|---|---|---|
| Water Quality | 2.54 | 2.78 | 1.78 |
| Drinking Water | 6.00 | 5.14 | 5.11 |
| Hazardous Waste | 24.59 | 21.94 | 13.01 |
| Oil Spills | 0.00 | 1.09 | 1.98 |
| Pesticides | .23 | .13 | .14 |
| Radiation | 2.70 | 1.00 | .00 |
| Multimedia | 8.99 | 9.50 | 34.08 |
| Toxic Substances | 2.11 | 1.98 | .95 |
| Superfund | 34.50 | 36.25 | 28.99 |
| Leaking Underground Storage Tanks | .77 | .74 | .76 |
| Total | 108.99 | 106.99 | 112.95 |

## THE DEPARTMENT OF DEFENSE

Mechanical engineering pervades the entire range of defense research and development programs. A generalized discussion of the subject is therefore necessary.

Under what the Secretary of Defense termed the "first truly post-Cold War budget," total defense spending will decline by 5.0 percent over the FY 1993 level while the Research, Development, Test, and Evaluation (RDT&E) portion will suffer a less severe cut of 1.2 percent. Table VII shows that substantial reductions would be made in the two categories of basic research and in strategic programs. The largest dollar increases within RDT&E are for tactical programs and Defensewide Mission Support such as laboratories and test facilities.

The Department of Defense under the new Administration has initiated a "bottom-up review" of defense spending priorities to determine a long-range budget plan in light of the relaxation of international tensions and economic realities. Later this year, it is anticipated that programs with insufficient merit, especially in the research and development phase, will be curtailed or canceled. As one element of this plan, the DOD will retain technologies with potential application in the civilian economy as well as military systems. Areas of focus in these "dual-use technologies" include high definition systems, advanced materials, microelectronics, X-ray lithography, and flatpanel displays. The DOD's Advanced Research Projects Agency (ARPA) will manage the dual-use program.

**TABLE VII.** The Department of Defense RDT&E (Millions of Dollars)

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| Technology Base | 4,104 | 4,920 | 4,376 |
| Advanced Technology Development | 6,314 | 4,053 | 3,607 |
| Strategic Programs | 4,240 | 6,345 | 4,776 |
| Tactical Programs | 14,313 | 14,131 | 15,904 |
| Intelligence & Communications | 4,921 | 4,702 | 5,113 |
| Defensewide Mission Support | 4,225 | 4,025 | 4,843 |
| Total | 38,117 | 38,176 | 38,619 |

## THE DEPARTMENT OF TRANSPORTATION

The FY 1994 R&D budget request for the Department of Transportation reflects the new policy directives of the Clinton Administration to use technology in meeting national objectives. The request includes $687.8 million for research and development, a 6.4 percent increase over the FY 1993 appropriated level. Key initiatives include technology for high-speed ground transportation and Intelligent Vehicle Highway Systems (IVHS).

Table VIII includes R&D program areas that incorporate mechanical engineering activities within the Department of Transportation.

**TABLE VIII. The Department of Transportation (Millions of Dollars)**

| | FY 1992 Actual | FY 1993 Estimate | FY 1994 Request |
|---|---|---|---|
| **Federal Highway Administration** | | | |
| Intelligent Vehicle Highway System | 36.0 | 214.3 | 221.1 |
| **National Highway Traffic Safety Administration** | | | |
| Operations & Research | 82.17 | 98.33 | 79.69 |
| Operations & Research Highway Trust Fund | 44.17 | 46.17 | 50.33 |
| **Federal Railroad Administration** | | | |
| Railroad Research & Development | 22.80 | 33.30 | 18.17 |
| **Federal Transit Administration** | | | |
| Transit Planning & Research | — | 85.00 | 85.00 |
| University Transportation Centers | — | 6.00 | 6.00 |
| **Federal Aviation Administration** | | | |
| Aircraft Safety Technology | 70.80 | 36.37 | 41.18 |
| System Security Technology | — | 35.93 | 35.93 |
| Environment & Energy | — | 6.43 | 5.39 |
| Innovative/cooperative Research | — | 8.36 | 4.73 |
| Total | 255.94 | 570.19 | 547.52 |

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From 1976 through 1982, the annual AAAS R&D Colloquia were held in June; from 1984 through 1986, in March; and since 1987, in April, following publication of the latest *R&D Report*. The *Proceedings* of these Colloquia were published separately each year and, in general, include the texts of speeches delivered during the meetings and in some cases edited versions of the discussions that followed. (The *Proceedings* of the 1983 Colloquium are included in *AAAS Report VIII*).

### AAAS SCIENCE AND TECHNOLOGY POLICY YEARBOOK, 1991–92

This new series replaces the *Colloquium Proceedings* as the second publication in the R&D Budget and Policy Programs's annual series of three publications. It contains most of the Colloquium addresses, as well as both original and previously published articles by leading figures in science and technology policy.

### PRELIMINARY ANALYSES: FY 1979–FY 1984

Prepared by an Intersociety Working Group comprised of representatives of several scientific, engineering and higher education associations, these reports review, in a preliminary fashion, the overall federal budget for R&D, the R&D budgets of several major R&D agencies, and the R&D funding situation in a number of scientific and engineering disciplines. In general, they are published within a few weeks after release of a given year's budget.

### CONGRESSIONAL ACTION ON R&D IN THE FEDERAL BUDGET: FY 1979–FY 1993

These brief reports, published in the fall, are also prepared in collaboration with the Intersociety Working Group. They summarize the results of congressional action on R&D elements in the federal budget. Their format permits comparison between the President's proposals for a given fiscal year and congressional allocations.

### R&D IN THE 1980S: A SPECIAL REPORT

This report, prepared in the fall of 1988, reviews the history of R&D policy and funding in the Reagan years.

### FEDERAL FUNDING FOR ENVIRONMENTAL R&D: A SPECIAL REPORT

This 1992 report contains a comprehensive analysis of federal support for environmental research and development, originally prepared for a congressionally mandated study by the National Academy of Sciences's Committee on Environmental Research.

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